United States Department of Agriculture

Soil Conservation Service

In cooperation with Minnesota Agricultural Experiment Station

Soil Survey of Morrison County, Minnesota

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How To Use This Soil Survey

General Soil Map

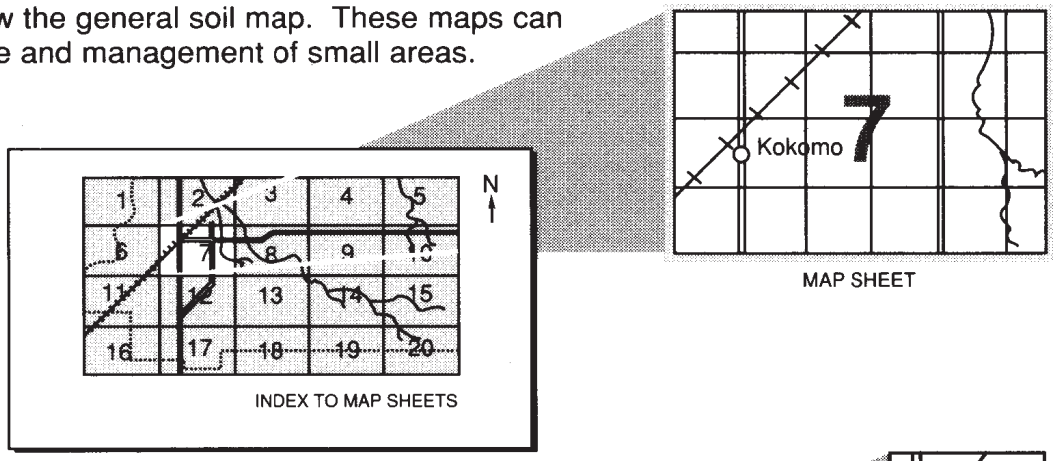
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

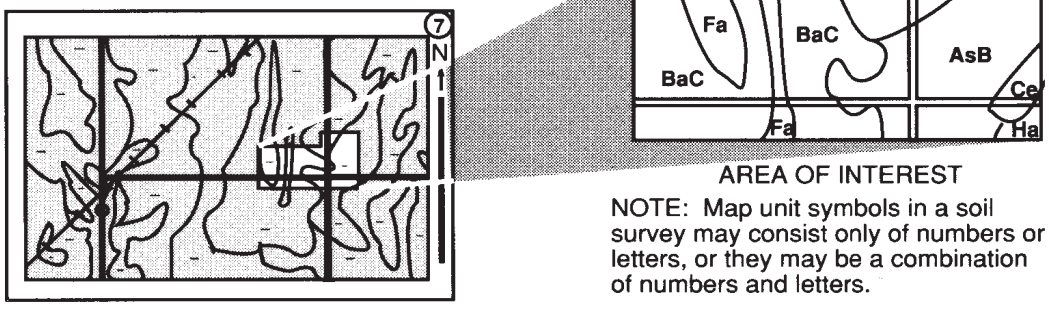
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1986. Soil names and descriptions were approved in March 1987. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1986. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. Other assistance was provided by the Agricultural Extension Service and the Soil and Water Conservation Board. The survey was partially funded by the Legislative Commission for Minnesota Resources and Morrison County. It is part of the technical assistance furnished to the Morrison Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: The harvest of small grain in an area of Flak sandy loam, east of Little Falls.

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Issued January 1994

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Morrison County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Gary R. Nordstrom

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State Conservationist
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Soil Survey of Morrison County, Minnesota

By William H. Brug, Jr., and Jerome F. Gorton, Soil Conservation Service

Fieldwork by William H. Brug, Jr., Timothy R. Fredbo, Jerome F. Gorton, Michael L. Lieser, Charles T. Saari, and Kim D. Steffen, Soil Conservation Service, and Roger Berggren, Peter Hartman, and Charles K. Sutton, Minnesota Agricultural Experiment Station

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Minnesota Agricultural Experiment Station

General Nature of the County

MORRISON COUNTY is in central Minnesota (fig. 1). It has a total land area of 721,280 acres, or 1,127 square miles. The total water area is about 19,200 acres.

The county has 13 incorporated cities and villages: Randall, Flensburg, Sobieski, Upsala, Elmdale, Bowlus, Little Falls, Royalston, Buckman, Pierz, Lastrup, Harding, and Hillman. Little Falls, the county seat and the largest community in the county, is in the west-central part of the county, adjacent to the Mississippi River. In 1980, Little Falls had a population of 7,250 and the county had a population of 29,311. Little Falls is less than 100 miles from the Minneapolis-St. Paul metropolitan area. The county occupies a strategic position along the major routes that connect the metropolitan area and Minnesota's lake region in the northern and northeastern parts of the state. It is about 41 miles wide from east to west. The Mississippi River flows through the middle of the county.

Dairy farming is the principal farming enterprise. Corn, small grain, and poultry are the main farm products.

Small manufacturing plants are located in Little Falls. They include plants that manufacture boats and plastics.

The soils in Morrison County formed during several advances of the late Wisconsin Glacier. They formed in glacial till on end moraines, ground moraines, and drumlins; in glacial outwash on outwash plains; in lacustrine sediment on glacial lake beds, and in alluvium along rivers and streams.

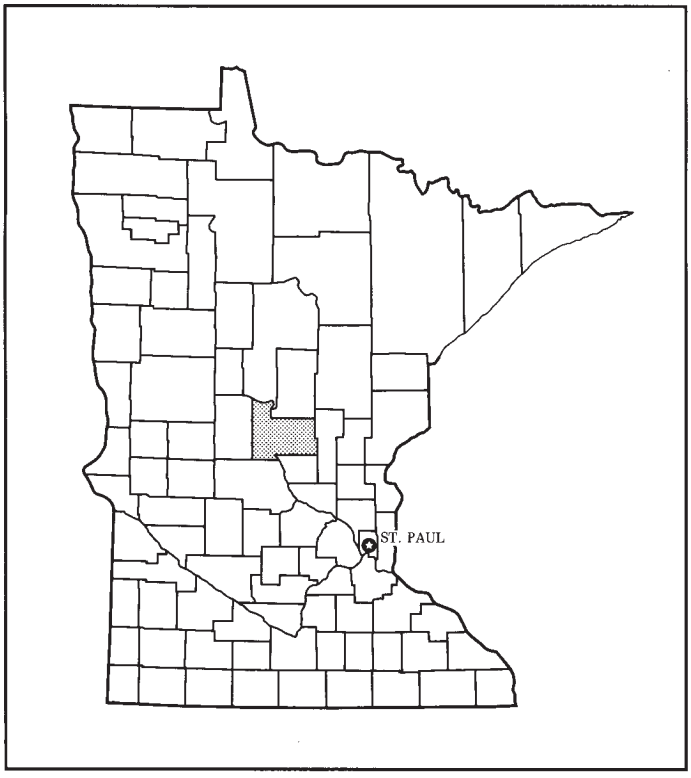

Figure 1.—Location of Morrison County in Minnesota.

Quantity and Quality of Ground Water

The bedrock in the Little Falls area consists almost entirely of metamorphic and igneous rocks. It contains relatively small amounts of ground water. Generally, the bedrock surface slopes southward and is 0 to 150 feet below the land surface.

The more productive sources of ground water in the county are in glacial drift. The glacial drift consists partly of gray glacial till deposited by the Wadena Lobe. It is overlain by red and brown glacial till deposited by the Superior and Rainy Sublobes. Outwash deposits that are buried within the glacial till may yield water supplies adequate for irrigation in some areas. The most readily available source of ground water in the county is in the glacial outwash located in the Hubbard-Duelm-Isan association. The soils in this association consist mostly of moderately sorted or well sorted sand and gravel. Water in the aquifer is primarily unconfined. Some of the thickest outwash is about 100 feet thick. It is in a channel that was probably cut into the bedrock by glacial meltwater as it drained southward, roughly parallel to the present Mississippi River, on the east side of the present channel. In this area and in a few other small areas, wells yield more than 1,000 gallons of water per minute. In more than two-thirds of the county, wells in the surficial aquifer generally yield less than 300 gallons per minute. Individual wells in this area generally supply insufficient amounts of water for irrigation *(7)*.

An estimated average of 86,000 acre-feet of water moves through the surficial aquifer system annually. Most of the recharge to the system is through precipitation. Discharge mostly occurs as evapotranspiration, base flow to the Mississippi River, and base flow to streams and lakes.

The aquifer system can safely support a sustained withdrawal of 18,000 acre-feet of water per year. Withdrawals of 36,000 to 72,000 acre-feet per year are likely to cause declines in water-table levels that can be excessive in some parts of the county. Extensive ground-water development near lakes can cause significant declines in lake levels. Most stream flow is not seriously depleted; however, a few smaller streams are affected by the largest programmed withdrawals.

The chemical quality of water in the aquifer is considered satisfactory for irrigation. The water is moderately hard to very hard.

The increased use of fertilizers that commonly accompany irrigation could introduce nitrate into the ground water. Because it is unconfined, the surficial aquifer is subject to nitrate pollution over large areas.

History

Kitty Tepley, district administrator, Morrison County Soil and Water Conservation District, helped prepare this section.

In the mid-1600's, two Frenchmen, Groseilliers and Raddison, were the first Europeans to visit the area. In 1750, an overwintering station, probably called Fort De Quesene, was located adjacent to what is now Little Falls, along the Mississippi River. As part of the Mississippi River basin, the survey area was included in the Louisiana Purchase of 1803. After the transaction, Thomas Jefferson wanted a report on the purchased land. He sent the Lewis and Clark Expedition up the Missouri River to the west coast and Lt. Zebulon Montgomery Pike north up the Mississippi River to its source. On October 16, 1803, Pike encountered the long series of rapids at the spot that is now known as Little Falls.

Trade routes and trails developed along the Mississippi River. A trading post was built at the site of the Little Falls rapids in 1826, along the Red River Oxcart Trail. Fort Ripley was constructed in 1849. It was renamed Camp Ripley in 1929, when it became a National Guard training area. It has been expanded to more than 52,000 acres and presently provides summer and winter training facilities.

Except for some areas of open prairie along the major rivers, Morrison County was originally timberland. Hardwoods and pine were plentiful. Logging white pine was the chief enterprise in the settlement period. The county is in the deciduous hardwood transition area between the prairie to the southwest and the pine forests to the northeast.

The river rapids that were an obstacle to Pike's expedition were viewed with enthusiasm by early industrialists. The first of these industrialists was James Green, who arrived in 1848. He built a dam to power a sawmill. A log dam higher on the river was built in 1887. In 1920, this dam was replaced by the present concrete dam.

Little Falls became the county seat in 1856. By 1868, the county had three permanent ferries across the Mississippi River, at Belle Prairie, Little Falls, and Bellevue. The first train arrived in Little Falls on November 1, 1877. The railroad served only the area east of the river.

The 1890's were years of growth and industrial development. In 1890, the Hennepin Paper Company became the first papermill in Minnesota. It produced pulp for newsprint. By 1891, the county could support a major lumbering operation. The Mississippi River and its tributaries were used to transport the logs from a vast area of virgin pine. The lumber was shipped by railroad

to unlimited markets. Richard D. Musser and Charles Weyerhauser organized the Pine Tree Lumber Company, which later became the Weyerhauser Paper Company. The huge mill was in operation until it was destroyed by fire in 1919.

Charles A. Lindberg, Sr., was a prominent Little Falls attorney. He served in Congress from 1907 to 1917. His son, Charles Lindberg, Jr., was the first pilot to make a solo flight across the Atlantic Ocean, from New York to France.

Climate

Table 1 gives data on temperature and precipitation for the survey area as recorded at Little Falls in the period 1951 to 1981. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 12 degrees F and the average daily minimum temperature is 1 degree. The lowest temperature on record, which occurred at Little Falls on January 9, 1977, is -41 degrees. In summer, the average temperature is 68 degrees and the average daily maximum temperature is 81 degrees. The highest recorded temperature, which occurred at Little Falls on August 18, 1976, is 101 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 26 inches. Of this, nearly 20 inches, or about 77 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 16 inches. The heaviest 1-day rainfall during the period of record was 4.70 inches at Little Falls on August 1, 1953. Thunderstorms occur on about 36 days each year.

The average seasonal snowfall is about 41 inches. The greatest snow depth at any one time during the period of record was 57 inches. On the average, 56 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 65 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 12 miles per hour, in spring.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind

and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by two or three kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

As a result of changes in soil series concepts, different soil patterns, and variations in map unit design, some soil boundaries and names do not match those in the published soil surveys of adjacent counties.

Soil Descriptions

1. Hubbard-Duelm-Isan Association

Nearly level or gently sloping, excessively drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained, sandy and loamy soils; on outwash plains and valley trains

Areas of this association are along the Mississippi and Crow Wing Rivers. Slopes range from 0 to 6 percent. This association makes up about 13 percent of the county. It is about 48 percent Hubbard soils, 20 percent Duelm soils, 12 percent Isan soils, and 20 percent minor soils.

The Hubbard soils are excessively drained. They are on plane or slightly convex rises. Typically, the surface layer is black loamy sand about 9 inches thick. The subsurface layer is very dark brown loamy sand about 5 inches thick. The subsoil is sand about 23 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The underlying material to a depth of about 60 inches is brown sand.

The Duelm soils are somewhat poorly drained or moderately well drained. They are on side slopes and on plane or slightly convex rises. Typically, the surface layer is very dark gray loamy sand about 7 inches thick. The subsurface layer is very dark brown loamy sand about 4 inches thick. The subsoil is about 22 inches thick. It is dark grayish brown and mottled. It is sand in the upper part and coarse sand in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled coarse sand.

The Isan soils are poorly drained or very poorly drained. They are on broad flats and in shallow depressions. Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is very dark gray, mottled loamy sand about 5 inches thick. The subsoil is dark grayish brown, mottled sand about 12 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled coarse sand.

Of minor extent in this association are the excessively drained Menahga soils on convex rises, the very poorly drained Markey and Seelyeville soils in deep depressions, and the somewhat poorly drained Winterfield and poorly drained and very poorly drained Fordum soils on flood plains.

Most areas of this association are used as cropland. The major crops are corn, soybeans, and small grain. The Hubbard and Isan soils are poorly suited to the production of crops. The Hubbard soils are droughty, and the Isan soils are wet. The Duelm soils are fairly well suited to the production of crops, but droughtiness is a management concern.

2. Mahtomedi-Menahga Association

Nearly level to very steep, excessively drained, sandy soils; on outwash plains, moraines, and valley trains

Areas of this association are on broad plains, sloping ridges, and side slopes. Slopes range from 0 to 45 percent. This association makes up about 9 percent of the county. It is about 45 percent Mahtomedi soils, 40 percent Menahga soils, and 15 percent minor soils (fig. 2).

The Mahtomedi soils are on convex rises or knolls

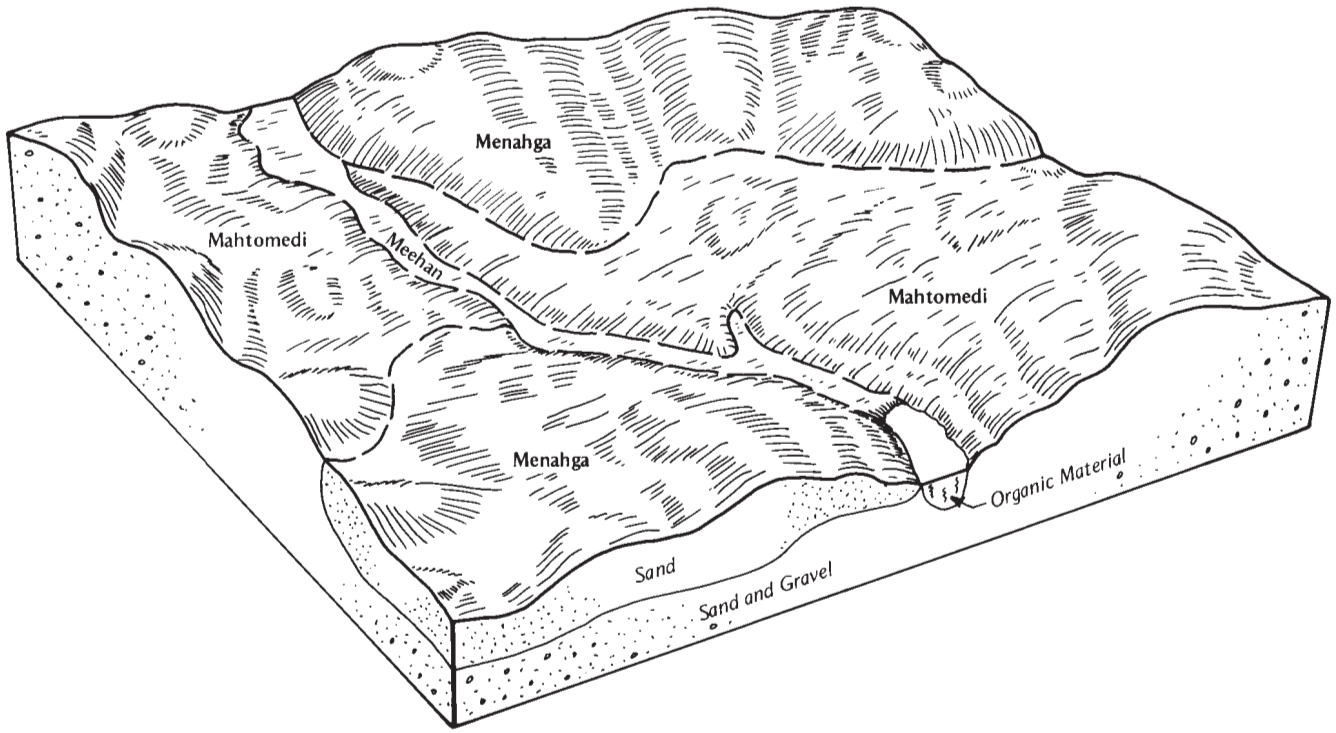

Figure 2.—Pattern of soils and underlying material in the Mahtomedi-Menahga association.

and on side slopes. Typically, the surface layer is very dark gray loamy sand about 5 inches thick. The subsurface layer is brown sand about 5 inches thick. The subsoil is about 25 inches thick. It is brown gravelly sand in the upper part and dark yellowish brown coarse sand in the lower part. The underlying material to a depth of about 60 inches is yellowish brown gravelly sand.

The Menahga soils are on plane or slightly convex rises or knolls and on sloping moraines. Typically, the surface layer is black loamy sand about 2 inches thick. The subsurface layer is very dark grayish brown sand about 3 inches thick. The subsoil is sand about 16 inches thick. In sequence downward it is brown, dark yellowish brown, and yellowish brown. The underlying material to a depth of about 60 inches is yellowish brown coarse sand.

Of minor extent in this association are the somewhat excessively drained Chetek soils on knolls, the somewhat poorly drained Meehan soils on broad flats and in swales, and the very poorly drained Markey soils in deep depressions.

Most areas of this association are used as pasture or woodland. Some crops are grown in the less sloping areas, but the major soils are poorly suited to cropland. Droughtiness is the main management concern. If the soils in the more sloping areas are disturbed, water erosion can be a hazard.

3. Pierz-Arvilla Association

Nearly level or gently sloping, well drained or somewhat excessively drained, loamy soils; on outwash plains and valley trains

Areas of this association are on broad plains that have slight relief. Slopes range from 0 to 6 percent. This association makes up about 4 percent of the county. It is about 57 percent Pierz soils, 19 percent Arvilla soils, and 24 percent minor soils.

The Pierz soils are well drained. They are on plane or slightly convex rises or on gently sloping broad plains. Typically, the surface layer is black sandy loam about 10 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is brown sandy loam about 14 inches thick. The underlying material to a depth of about 60 inches is brown very gravelly coarse sand.

The Arvilla soils are somewhat excessively drained. They are on plane or slightly convex rises or on gently sloping broad plains. Typically, the surface layer is

black sandy loam about 10 inches thick. The subsoil is dark brown sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown and dark grayish brown gravelly coarse sand.

Of minor extent in this association are the somewhat excessively drained Chetek soils on convex rises, the excessively drained Mahtomedi soils on convex rises or ridges, the somewhat poorly drained Oesterle soils on broad flats and in swales, the poorly drained Forada soils in swales and drainageways, and the somewhat poorly drained and moderately well drained Growton soils on rises.

Nearly all of this association is used as cropland. The major crops are corn, soybeans, small grain, and alfalfa. The Pierz soils are well suited to cropland. Water erosion is a management concern in the more sloping areas. The Arvilla soils are fairly well suited to the production of crops. Droughtiness and water erosion are management concerns in areas of the Arvilla soils.

4. Chetek-Mahtomedi-Oesterle Association

Nearly level to very steep, somewhat excessively drained, excessively drained, and somewhat poorly drained, loamy and sandy soils; on outwash plains, stream terraces, and moraines

Areas of this association are on gently sloping plains, sloping ridges, and side slopes. Slopes range from 0 to 45 percent. This association makes up about 5 percent of the county. It is about 34 percent Chetek soils, 24 percent Mahtomedi soils, 10 percent Oesterle soils, and 32 percent minor soils.

The Chetek soils are somewhat excessively drained. They are on knolls and convex side slopes. Typically, the surface layer is dark grayish brown sandy loam about 6 inches thick. The subsurface layer is brown sandy loam about 4 inches thick. The subsoil is sandy loam about 10 inches thick. It is dark yellowish brown in the upper part and brown in the lower part. The underlying material to a depth of about 60 inches is brown gravelly sand.

The Mahtomedi soils are excessively drained. They are on convex rises or knolls and on side slopes. Typically, the surface layer is very dark gray loamy sand about 5 inches thick. The subsurface layer is brown sand about 5 inches thick. The subsoil is about 25 inches thick. It is brown gravelly sand in the upper part and dark yellowish brown coarse sand in the lower part. The underlying material to a depth of about 60 inches is yellowish brown gravelly sand.

The Oesterle soils are somewhat poorly drained. They are on slightly convex rises and broad flats. Typically, the surface layer is very dark brown sandy loam about 6 inches thick. The next 3 inches is grayish brown sandy loam that has tongues of brown sandy loam. The subsoil is brown, mottled sandy loam about 14 inches thick. The underlying material to a depth of about 60 inches is reddish brown. It is very gravelly coarse sand in the upper part and very gravelly sand in the lower part.

Of minor extent in this association are the excessively drained Emmert soils on side slopes, the very poorly drained Warman soils in shallow depressions and on flats, and the very poorly drained Markey, Rifle, and Seelyeville soils in deep depressions.

Most areas of this association are used as cropland. The major crops are corn, small grain, and alfalfa. The Oesterle soils are well suited, the Chetek soils are fairly well suited, and the Mahtomedi soils are poorly suited to the production of crops. The Chetek soils are easily eroded. The Mahtomedi soils are droughty. They are better suited to woodland than to the production of crops. The Oesterle soils are seasonally wet.

5. Pomroy Association

Nearly level to sloping, well drained or moderately well drained, sandy soils; on drumlins and ground moraines

Areas of this association are on gently rolling uplands that border outwash plains. Slopes range from 1 to 12 percent. This association makes up about 5 percent of the county. It is about 65 percent Pomroy soils and 35 percent minor soils (fig. 3).

The Pomroy soils are on crests and convex side slopes. Typically, the surface layer is very dark grayish brown loamy fine sand about 9 inches thick. The subsurface layer is brown loamy fine sand about 11 inches thick. The subsoil is about 22 inches thick. It is brown loamy fine sand in the upper part and firm, brown sandy loam in the lower part. The underlying material to a depth of about 60 inches is brown dense till that crushes to sandy loam.

Of minor extent in this association are the excessively drained Sartell and Menahga soils on convex rises, the somewhat poorly drained Watab soils on broad flats and in swales, and the very poorly drained Nokasippi soils in depressions.

Most areas of this association are used as cropland. The major crops are corn, soybeans, and small grain. The major soils are poorly suited to agricultural crops. The main management concern is droughtiness, but water erosion and soil blowing also are hazards in some areas.

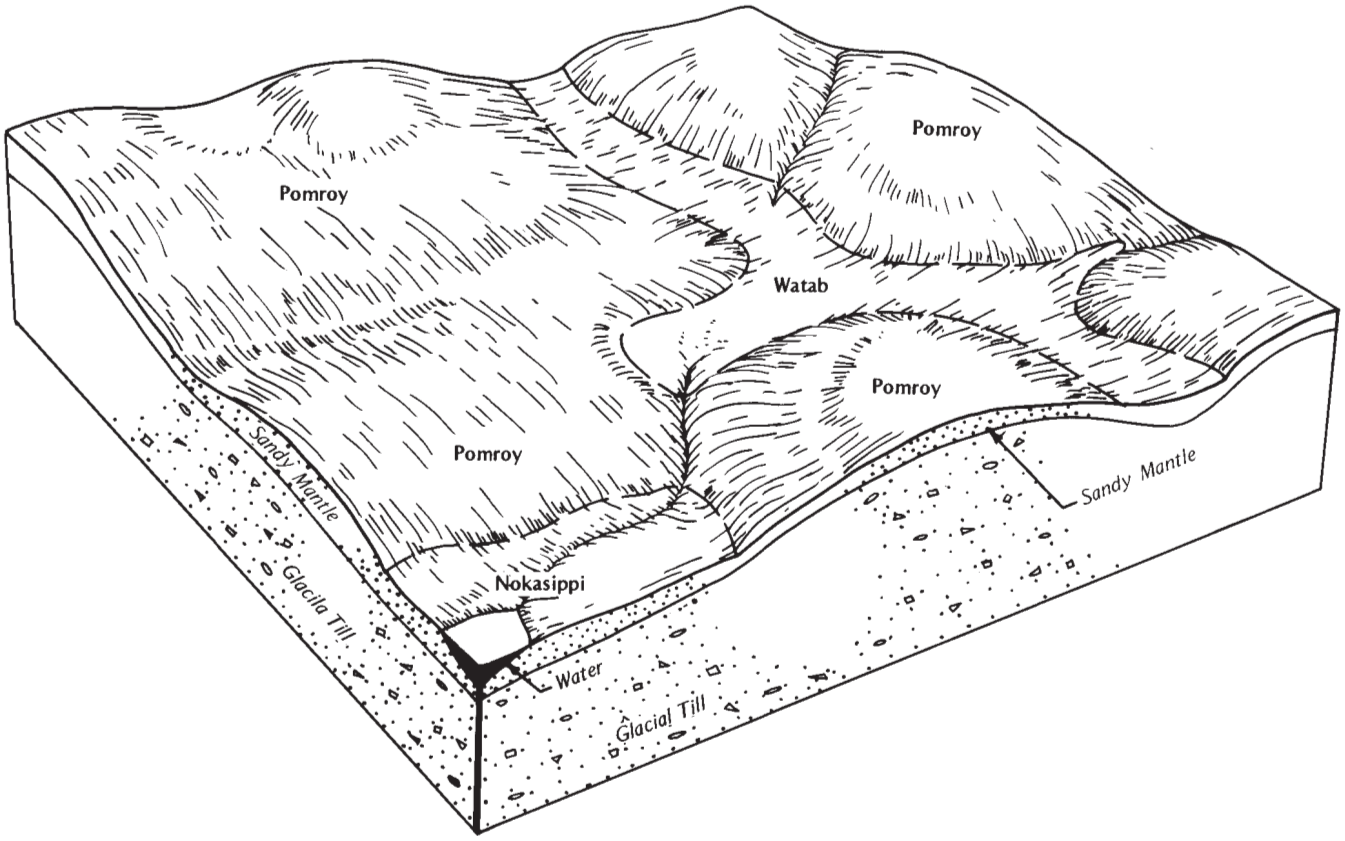

Figure 3.—Pattern of soils and underlying material in the Pomroy association.

6. Mora-Ronneby-Freer Association

Nearly level or gently sloping, moderately well drained or somewhat poorly drained, loamy or silty soils; on drumlins and moraines

Areas of this association are on drumlins and moraines that have low or moderate relief and that rise 5 to 20 feet above the adjacent low areas. Slopes range from 0 to 4 percent. This association makes up about 7 percent of the county. It is about 33 percent Mora soils, 28 percent Ronneby soils, 10 percent Freer soils, and 29 percent minor soils.

The Mora soils are moderately well drained. They are on crests and side slopes. Typically, the surface layer is black fine sandy loam about 5 inches thick. The subsurface layer is brown fine sandy loam about 6 inches thick. The subsoil is mottled, fine sandy loam about 33 inches thick. It is brown in the upper part and yellowish red and firm in the lower part. The underlying material to a depth of about 60 inches is dark reddish brown, mottled dense till that crushes to fine sandy loam.

The Ronneby soils are somewhat poorly drained. They are on side slopes, on broad flats, and in swales. Typically, the surface layer is black loam about 5 inches thick. The subsurface layer is dark grayish brown, mottled fine sandy loam about 6 inches thick. The subsoil is mottled sandy loam about 34 inches thick. In sequence downward it is brown, reddish brown, and dark reddish brown. The lower part of the subsoil is firm. The underlying material to a depth of about 60 inches is dark reddish brown dense till that crushes to sandy loam.

The Freer soils are somewhat poorly drained. They are on broad flats and in swales. Typically, the surface layer is black silt loam about 4 inches thick. The subsurface layer is grayish brown, mottled silt loam about 7 inches thick. The next 5 inches is grayish brown, mottled silt loam that has tongues of yellowish brown loam. The subsoil is about 28 inches thick. In sequence downward it is yellowish brown, mottled loam; brown loam; and reddish brown, firm sandy loam. The underlying material to a depth of about 60 inches is reddish brown dense till that crushes to sandy loam.

Of minor extent in this association are the well drained Milaca soils on side slopes and ridges, the moderately well drained Freeon soils on plane or slightly convex rises, the very poorly drained Prebish soils in shallow depressions or drainageways, and the very poorly drained Cathro and Seelyeville soils in deep depressions.

About half of this association is used as cropland, and half is used as pasture or woodland. The major soils are well suited to agricultural crops. The main management concerns are wetness in the nearly level areas and water erosion in the more sloping areas.

7. Brainerd-Nokay-Prebish Association

Nearly level or gently sloping, moderately well drained, somewhat poorly drained, and very poorly drained, loamy soils; on drumlins and moraines

Areas of this association are on drumlins and moraines that have low or moderate relief and that rise 5 to 20 feet above the adjacent low areas. Slopes range from 0 to 4 percent. This association makes up about 36 percent of the county. It is about 45 percent Brainerd soils, 30 percent Nokay soils, 10 percent Prebish soils, and 15 percent minor soils (fig. 4).

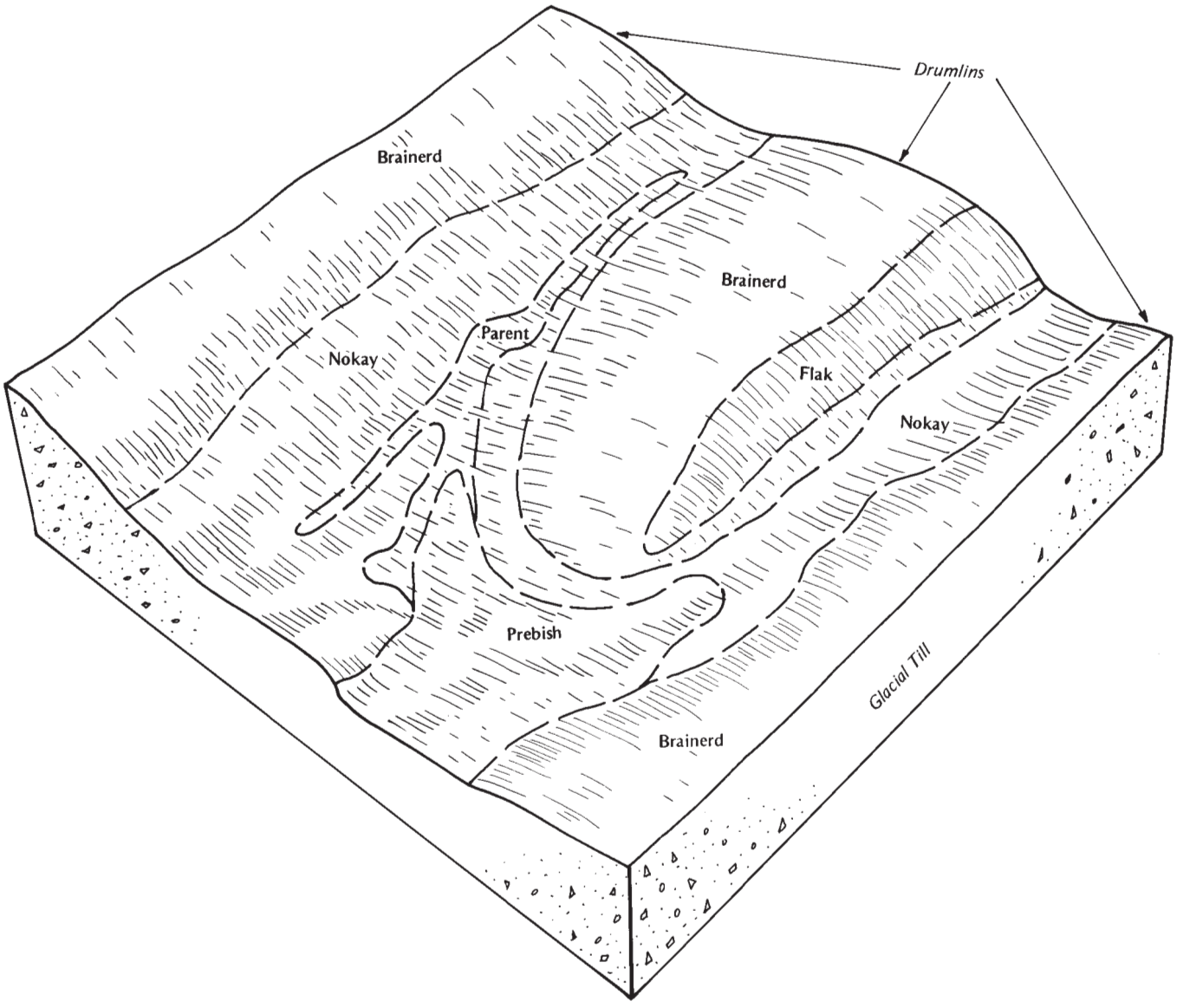

Figure 4.—Pattern of soils and underlying material in the Brainerd-Nokay-Prebish association.

The Brainerd soils are moderately well drained. They are on crests and side slopes. Typically, the surface layer is very dark grayish brown sandy loam about 6 inches thick. The subsurface layer is brown, mottled sandy loam about 5 inches thick. The subsoil also is brown, mottled sandy loam. It is about 30 inches thick. The lower part of the subsoil is firm. The underlying material to a depth of about 60 inches is brown, mottled dense till that crushes to sandy loam.

The Nokay soils are somewhat poorly drained. They are on side slopes, on broad flats, and in swales. Typically, the surface layer is very dark gray loam about 6 inches thick. The subsurface layer is grayish brown, mottled fine sandy loam about 8 inches thick. The subsoil is brown, mottled sandy loam about 27 inches thick. It is firm in the lower part. The underlying material to a depth of about 60 inches is brown, mottled dense till that crushes to sandy loam.

The Prebish soils are very poorly drained. They are on flats and in drainageways and shallow depressions on uplands. Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is black, mottled loam about 6 inches thick. The subsoil is grayish brown, mottled fine sandy loam about 29 inches thick. The underlying material to a depth of about 60 inches is brown, mottled sandy loam.

Of minor extent in this association are the well drained Flak soils on side slopes and ridges, the poorly drained Parent soils in drainageways and swales, and the very poorly drained Cathro, Seelyeville, and Rifle soils in deep depressions and on broad flats.

Most areas of this association are used as cropland. The major crops are corn, soybeans, small grain, and alfalfa. The Brainerd and Nokay soils are well suited to agricultural crops. Water erosion is the main management concern in areas of the Brainerd soils. Seasonal wetness is a management concern in areas of the Nokay soils. The Prebish soils are poorly suited to crop production because of wetness.

8. Cushing-Mahtomedi-DeMontreville Association

Nearly level to steep, excessively drained and well drained, loamy and sandy soils; on moraines and outwash plains

Areas of this association are on knolls and ridges on glacial moraines. Slopes range from 2 to 45 percent. This association makes up about 8 percent of the county. It is about 40 percent Cushing soils, 25 percent Mahtomedi soils, 20 percent DeMontreville soils, and 15 percent minor soils (fig. 5).

The Cushing soils are well drained. They are on slightly convex rises or ridges and on convex side slopes. Typically, the surface layer is black fine sandy loam about 5 inches thick. The subsurface layer is about 14 inches thick. It is brown fine sandy loam in the upper part and brown sandy loam in the lower part. The next 10 inches is brown sandy clay loam that has tongues of brown sandy loam. The subsoil is brown sandy clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is brown sandy loam.

The Mahtomedi soils are excessively drained. They are on knolls, ridges, and side slopes. Typically, the surface layer is black loamy sand about 5 inches thick. The subsurface layer is brown coarse sand about 5 inches thick. The subsoil is yellowish brown gravelly coarse sand about 28 inches thick. The underlying material to a depth of about 60 inches is brown gravelly coarse sand.

The DeMontreville soils are well drained. They are on knolls or ridges and on side slopes of moraines. Typically, the surface layer is very dark brown loamy fine sand about 6 inches thick. The subsurface layer is brown loamy sand about 21 inches thick. The subsoil is about 19 inches thick. It is brown loamy sand in the upper part and brown sandy clay loam in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam.

Of minor extent in this association are the somewhat poorly drained Alstad soils on side slopes and in swales, the excessively drained Emmert soils on crests and ridges, the poorly drained Parent and very poorly drained Prebish soils in shallow depressions, and the very poorly drained Rifle soils in the deeper depressions.

Most areas of this association are used as woodland. The major soils are fairly well suited or poorly suited to the production of crops. Water erosion is a management concern in areas of the Cushing soils. Droughtiness is a management concern in areas of the DeMontreville and Mahtomedi soils.

9. Growton-Holdingford-Parent Association

Nearly level to moderately steep, well drained to poorly drained, loamy soils; on drumlins and moraines

Areas of this association are on drumlins and moraines that have low or moderate relief and that rise 5 to 30 feet above the adjacent low areas. Slopes range from 0 to 15 percent. This association makes up about 7 percent of the county. It is about 41 percent Growton soils, 17 percent Holdingford soils, 12 percent Parent soils, and 30 percent minor soils.

The Growton soils are somewhat poorly drained or moderately well drained. They are on broad flats or on crests and side slopes. Typically, the surface layer is very dark grayish brown sandy loam about 9 inches

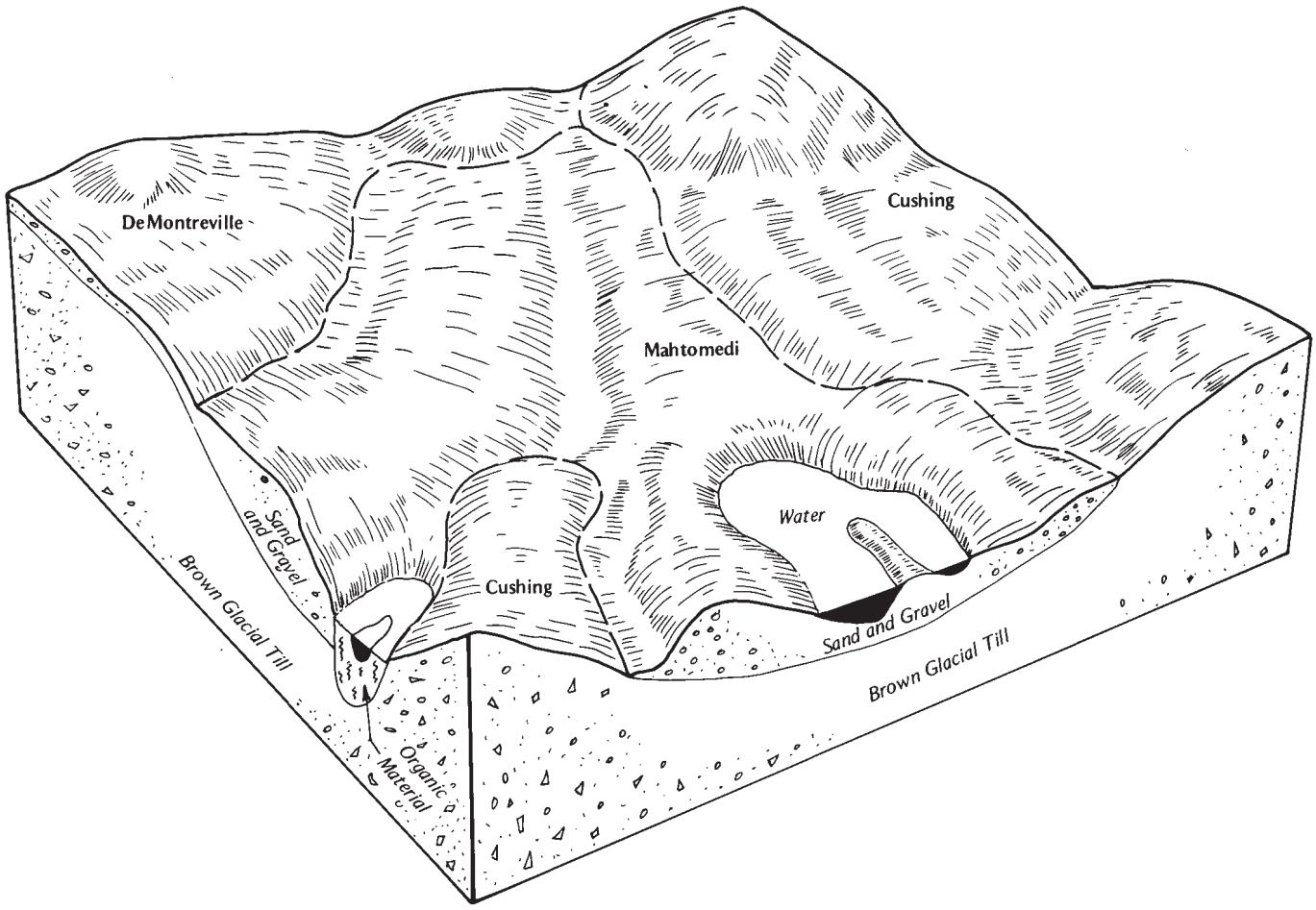

Figure 5.—Pattern of soils and underlying material in the Cushing-Mahtomedi-DeMontreville association.

thick. The subsurface layer is brown, mottled sandy loam about 10 inches thick. The subsoil also is brown, mottled sandy loam. It is about 25 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown, mottled sandy loam.

The Holdingford soils are well drained. They are on crests, ridges, and convex side slopes. Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is brown sandy loam about 9 inches thick. The subsoil also is brown sandy loam. It is about 32 inches thick. The underlying material to a depth of about 60 inches is brown sandy loam.

The Parent soils are poorly drained. They are on broad flats, in swales, and in drainageways. Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark gray, mottled loam about 5 inches thick. The subsoil is about 25 inches thick. In sequence downward it is dark grayish brown, mottled loam; grayish brown, mottled sandy loam; and brown, mottled, firm sandy loam. The underlying material to a depth of about 60 inches is brown, mottled dense till that crushes to sandy loam.

Of minor extent in this association are the very poorly drained Prebish soils on flats and in shallow depressions and the very poorly drained Cathro, Rifle, and Seelyeville soils in deep depressions and on broad flats.

Most areas of this association are used as cropland. The major crops are corn, soybeans, small grain, and alfalfa. The Growton and Holdingford soils are well suited to agricultural crops, and the Parent soils are fairly well suited to agricultural crops if the soils are adequately drained. Water erosion is the main management concern. Wetness is also a concern in the lower areas.

10. Seelyeville-Greenwood-Brainerd Association

Nearly level or gently sloping, very poorly drained and moderately well drained soils; on outwash plains, moraines, and drumlins

Areas of this association are on broad plains. Slopes range from 0 to 4 percent. This association makes up about 6 percent of the county. It is about 39 percent Seelyeville soils, 23 percent Greenwood soils, 28 percent Brainerd soils, and 10 percent minor soils.

The Seelyeville soils are very poorly drained. They are in deep depressions and on broad flats. Typically, they are highly decomposed, black muck about 60 inches thick.

The Greenwood soils are very poorly drained. They are in deep depressions. Typically, the upper layer is dark yellowish brown peat about 6 inches thick. The next layer is very dark brown peat about 6 inches thick. Below this is very dark brown mucky peat about 18 inches thick. The underlying material to a depth of about 60 inches is very dark grayish brown mucky peat.

The Brainerd soils are moderately well drained. They are on crests and side slopes. Typically, the surface layer is very dark grayish brown sandy loam about 6 inches thick. The subsurface layer is brown, mottled sandy loam about 5 inches thick. The subsoil also is brown, mottled sandy loam. It is about 30 inches thick. It is firm in the lower part. The underlying material to a depth of about 60 inches is brown, mottled dense till that crushes to sandy loam.

Of minor extent in this association are the very poorly drained Cathro and Rifle soils in landscape positions similar to those of the Seelyeville soils; the somewhat poorly drained Nokay soils on side slopes, on broad flats, and in swales; and the very poorly drained Prebish soils on flats, in drainageways, and in shallow depressions.

Most of the acreage in this association is idle land. The Brainerd soils are used as woodland. The Seelyeville and Greenwood soils are generally unsuited to cropland because of extreme wetness. The Brainerd soils are well suited to cropland. They are inaccessible, however, and are generally not used for growing crops. The major management concern is wetness.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Brainerd sandy loam, 1 to 4 percent slopes, extremely stony, is a phase of the Brainerd series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Fordum-Winterfield complex is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. The gravel pits in the Pits, gravel-Udorthents complex are an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

As a result of changes in soil series concepts, different soil patterns, and variations in map unit design, some soil boundaries and names do not match those in the published soil surveys of adjacent counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The "Glossary" defines many of the terms used in describing the soils.

This publication includes suggested management practices that are intended to increase crop protection, conserve soil resources, and protect the quality of the environment. Over a period of time, some or all of these conservation practices may or may not be in accordance with federal, state, and local laws.

Soil Descriptions

7A—Hubbard loamy sand, 0 to 2 percent slopes. This nearly level, excessively drained soil is on plane or slightly convex rises on outwash plains and valley trains. Individual areas are irregular in shape and range from 5 to more than 200 acres in size.

Typically, the surface layer is very dark brown loamy sand about 10 inches thick. The subsurface layer is dark brown loamy sand about 6 inches thick. The subsoil is sand about 26 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The underlying material to a depth of about 60

inches is yellowish brown sand. In some areas the soil has more fine sand.

Included with this soil in mapping are small areas of Duelm, Isan, and Menahga soils. Duelm soils are moderately well drained and somewhat poorly drained and are in slightly concave areas. Isan soils are poorly drained and very poorly drained and are in shallow depressions and drainageways. Menahga soils have a dark surface layer that is thinner than that of the Hubbard soil. They are excessively drained and are in more convex areas. Included soils make up about 3 to 10 percent of the unit.

Permeability is rapid in the Hubbard soil. The available water capacity is low. Surface runoff is slow. The content of organic matter is moderate or high.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is poorly suited to cultivated crops and small grain. Drought and soil blowing are hazards. Planting short-season varieties or irrigating helps to overcome the droughtiness. Cover crops, windbreaks, conservation tillage systems that leave protective amounts of crop residue on the surface, green manure crops, and stripcropping help to conserve soil moisture, control soil blowing, and increase the content of organic matter.

This soil is fairly well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, bur oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. In areas where the protective cover has been disturbed, soil blowing can occur. The hazard of water erosion is generally slight.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs, and the woodland ordination symbol is 2A.

7B—Hubbard loamy sand, 2 to 6 percent slopes. This gently sloping, excessively drained soil is on crests and side slopes on outwash plains and valley trains. Individual areas are irregular in shape and range from 5 to more than 200 acres in size.

Typically, the surface layer is black loamy sand about 9 inches thick. The subsurface layer is very dark brown loamy sand about 5 inches thick. The subsoil is sand about 23 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The underlying material to a depth of about 60 inches is brown sand. In some areas the soil has more fine sand. In other areas the surface soil is thinner and has a lower content of organic matter because of erosion.

Included with this soil in mapping are small areas of Duelm, Isan, and Menahga soils. Duelm soils are moderately well drained and somewhat poorly drained and are in slightly concave areas. Isan soils are poorly drained and very poorly drained and are in shallow depressions and drainageways. Menahga soils have a dark surface layer that is thinner than that of the Hubbard soil. They are excessively drained and are in convex areas. Included soils make up about 5 to 10 percent of the unit.

Permeability is rapid in the Hubbard soil. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is moderate or high.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is poorly suited to cultivated crops and small grain. Drought and soil blowing are hazards. Planting short-season varieties or irrigating helps to overcome the droughtiness. Cover crops, windbreaks, conservation tillage systems that leave protective amounts of crop residue on the surface, green manure crops, and stripcropping help to conserve soil moisture, control soil blowing, and increase the content of organic matter.

This soil is fairly well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, bur oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing

vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall. The hazard of erosion is generally slight.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs, and the woodland ordination symbol is 2A.

12C—Emmert gravelly loamy sand, 6 to 12 percent slopes. This sloping, excessively drained soil is on crests, ridges, and convex side slopes on outwash plains, eskers, terraces, and moraines. Individual areas are long and narrow and range from 5 to 40 acres in size.

Typically, the surface layer is black gravelly loamy sand about 4 inches thick. The subsoil is about 22 inches thick. It is very dark grayish brown gravelly loamy coarse sand in the upper part and dark yellowish brown very gravelly coarse sand in the lower part. The underlying material to a depth of about 60 inches is brown very gravelly coarse sand. In some areas the surface soil is thicker.

Included with this soil in mapping are small areas of Chetek, Mahtomedi, and Menahga soils. These soils are in landscape positions similar to those of the Emmert soil. Chetek soils formed in loamy material over sand and gravel. The content of gravel in the subsoil and underlying material of the Mahtomedi and Menahga soils is lower than that of the Emmert soil. Included soils make up about 5 to 10 percent of the unit.

Permeability is very rapid in the Emmert soil. The available water capacity is very low. Surface runoff is medium or rapid. The content of organic matter is low or moderately low.

Most areas are used as pasture or woodland. Some areas are used as cropland.

This soil is poorly suited to cultivated crops and small grain. Drought is the main hazard. Cover crops, conservation tillage systems that leave protective amounts of crop residue on the surface, green manure crops, and stripcropping help to conserve soil moisture, control water erosion, and increase the content of organic matter.

This soil is fairly well suited to pasture or hay. Drought is the main hazard. Suitable species include alfalfa, crownvetch, smooth bromegrass, big bluestem, little bluestem, and sideoats grama. Pasture rotation, weed control, deferment of grazing until the grasses reach a minimum grazing height, and applications of fertilizer help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, bur oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs, and the woodland ordination symbol is 6S.

12D—Emmert gravelly loamy sand, 12 to 40 percent slopes. This rolling to very steep, excessively drained soil is on convex summits and side slopes on outwash plains, eskers, terraces, and moraines. Individual areas are long and narrow and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown gravelly loamy sand about 4 inches thick. The subsoil is dark yellowish brown gravelly coarse sand about 10 inches thick. The underlying material to a depth of about 60 inches is brown very gravelly coarse sand. In some areas the surface layer is thicker.

Included with this soil in mapping are small areas of Chetek, Mahtomedi, and Menahga soils. Chetek soils formed in loamy material over sand and gravel. They are in the less rolling positions on the landscape. The content of gravel in the subsoil and underlying material of the Mahtomedi and Menahga soils is lower than that of the Emmert soil. The Mahtomedi and Menahga soils are in landscape positions similar to those of the Emmert soil. Included soils make up about 2 to 8 percent of the unit.

Permeability is very rapid in the Emmert soil. The available water capacity is very low. Surface runoff is

rapid. The content of organic matter is low or moderately low.

Most areas are used as woodland. This soil is generally unsuited to cropland, hay, and pasture because of the slope.

This soil is well suited to red pine, white pine, jack pine, bur oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall. The hazard of erosion is generally slight or moderate. Operating heavy machinery on the contour rather than up and down the slope minimizes the formation of channels that concentrate runoff and thus helps to control erosion. Equipment should be used with caution on the steep slopes.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. The slope limits the effectiveness of the windbreaks. Seedling mortality is moderate because of the droughtiness. Water erosion is a severe hazard unless most of the site is kept vegetated. Site preparation should be limited to an area of no more than 2 feet from where the tree or shrub is to be planted. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIIs, and the woodland ordination symbol is 6R.

25—Becker fine sandy loam. This nearly level, well drained soil is on plains or convex rises on flood plains. It is subject to rare flooding. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface soil is fine sandy loam about 32 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is very dark grayish brown loamy fine sand about 4 inches thick. The underlying material to a depth of about 60 inches is yellowish brown fine sand.

Included with this soil in mapping are small areas of Bowstring, Fordum, and Winterfield soils. These soils are in positions on the flood plains that are lower than those of the Becker soil. Bowstring soils are organic and are very poorly drained. Fordum soils are poorly drained and very poorly drained. Winterfield soils are somewhat poorly drained. Included soils make up about 2 to 7 percent of the unit.

Permeability is moderately rapid in the Becker soil. The available water capacity is low. Surface runoff is slow. The content of organic matter is moderate or high. The seasonal high water table is at a depth of 4 to 6 feet.

Most areas are used as cropland. Some areas are used for hay or pasture.

This soil is well suited to cultivated crops and small grain. Drought is a slight hazard. Soil blowing and rare flooding are additional hazards. Irrigation can help to overcome the droughtiness. Stripcropping, green manure crops, manure, conservation tillage systems that leave protective amounts of crop residue on the surface, and cover crops help to conserve soil moisture, control soil blowing, and maintain the content of organic matter.

This soil is well suited to grasses and legumes for hay or pasture. Drought and rare flooding are hazards. Suitable species include alfalfa, crownvetch, smooth bromegrass, big bluestem, little bluestem, indiangrass, and switchgrass. Overgrazing can result in soil blowing. Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIs. No woodland ordination symbol is assigned.

119B—Pomroy loamy fine sand, 1 to 6 percent slopes. This nearly level or gently sloping, well drained and moderately well drained soil is on crests and side slopes on drumlins and ground moraines. Individual areas are irregular in shape and range from 10 to more than 200 acres in size.

Typically, the surface layer is very dark grayish brown loamy fine sand about 9 inches thick. The subsurface layer is brown loamy fine sand about 11 inches thick. The subsoil is about 22 inches thick. It is brown loamy fine sand in the upper part and brown sandy loam in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the depth to glacial till is more than 40 inches. In other areas the surface layer is thicker and darker. In places depth to the water table is 1.5 to 2.5 feet.

Included with this soil in mapping are small areas of Brainerd, Flak, and Watab soils. Brainerd and Flak soils do not have a sandy surface layer. They are in landscape positions similar to those of the Pomroy soil

or are in more convex areas. Watab soils are somewhat poorly drained and are in swales. Included soils make up about 4 to 10 percent of the unit.

Permeability is rapid in the upper part of the Pomroy soil and moderately slow or very slow in the lower part. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is low or moderately low.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is fairly well suited to cultivated crops and small grain. Drought and soil blowing are hazards. Irrigation can help to overcome the droughtiness. Stripcropping, green manure crops, manure, conservation tillage systems that leave protective amounts of crop residue on the surface, and cover crops help to conserve soil moisture, control soil blowing, and maintain the content of organic matter.

This soil is well suited to grasses and legumes for hay or pasture. Drought is a hazard. Water erosion in the steeper areas and soil blowing are also hazards. Suitable species include alfalfa, crownvetch, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Seedling mortality is high because of the droughtiness. Poor seedling survival rates during dry years can be improved by careful planting of vigorous nursery stock. Harvesting or planting when the soil is not saturated by heavy spring rains minimizes compaction and helps to maintain the potential for seedling regeneration. The firm subsoil restricts the rooting depth of some plants.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Seedling mortality is moderate because of the droughtiness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIs, and the woodland ordination symbol is 4S.

119C—Pomroy loamy fine sand, 6 to 12 percent slopes. This sloping, well drained and moderately well drained soil is on crests, ridges, and convex side slopes on drumlins and ground moraines. Individual areas are irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is dark brown loamy fine sand about 7 inches thick. The subsurface layer is brown loamy fine sand about 21 inches thick. The subsoil is brown, firm sandy loam about 11 inches thick. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the depth to glacial till is more than 40 inches. In other areas the upper part of the soil is coarse sand. In places depth to the water table is 1.5 to 2.5 feet.

Included with this soil in mapping are small areas of Flak soils. These soils do not have a sandy surface layer. They are in landscape positions similar to those of the Pomroy soil. They make up about 5 to 10 percent of the unit.

Permeability is rapid in the upper part of the Pomroy soil and moderately slow or very slow in the lower part. The available water capacity is low. Surface runoff is medium or rapid. The content of organic matter is low or moderately low.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is poorly suited to cultivated crops and small grain. Drought and soil blowing are hazards. Cover crops, windbreaks, conservation tillage systems that leave protective amounts of crop residue on the surface, green manure crops, and stripcropping help to conserve soil moisture, control soil blowing, and increase the content of organic matter.

This soil is fairly well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Seedling mortality is high because of the droughtiness. Poor seedling survival rates during dry years can be improved by careful planting of vigorous

nursery stock. Harvesting or planting when the soil is not saturated by heavy spring rains minimizes compaction and helps to maintain the potential for seedling regeneration. The firm subsoil restricts the rooting depth of some plants.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Seedling mortality is moderate because of the droughtiness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs, and the woodland ordination symbol is 4S.

142—Nokay loam. This nearly level, somewhat poorly drained soil is on side slopes, on broad flats, and in swales on drumlins and ground moraines. Individual areas are irregular in shape and range from 20 to 80 acres in size.

Typically, the surface layer is very dark gray loam about 6 inches thick. The subsurface layer is grayish brown, mottled fine sandy loam about 8 inches thick. The subsoil is brown, mottled sandy loam about 27 inches thick. The underlying material to a depth of about 60 inches is brown, mottled sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the surface layer has more sand. In other areas it is very stony.

Included with this soil in mapping are small areas of Brainerd, Parent, and Prebish soils. Brainerd soils are moderately well drained and are on convex rises. Parent soils are poorly drained and are in swales and drainageways. Prebish soils are very poorly drained and are in shallow depressions. Included soils make up about 2 to 10 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Nokay soil and slow or very slow in the lower part. The available water capacity is moderate. Surface runoff is slow. The content of organic matter is moderate or high. A perched water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

If drained, this soil is well suited to cultivated crops and small grain. Wetness is the main limitation. Open ditches, subsurface drains, or surface drains help to remove excess water. Conservation tillage systems that leave protective amounts of crop residue on the surface, ridge tillage, and winter cover crops help to maintain or increase the content of organic matter and improve tilth.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Most stands are mixed northern red oak and quaking aspen. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. This soil is wet in the spring and after heavy rainfall because of the perched water table. The wetness limits the ability of the soil to support heavy machinery. Operating machinery only during dry periods minimizes compaction and increases the seedling survival rate. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIw, and the woodland ordination symbol is 5D.

144B—Flak sandy loam, 4 to 8 percent slopes. This gently sloping or sloping, well drained soil is on crests and side slopes on drumlins and ground moraines. Individual areas are long and narrow and range from 5 to 70 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 7 inches thick. The subsurface layer is brown fine sandy loam about 8 inches thick. The subsoil is brown sandy loam about 28 inches thick. The underlying material to a depth of about 60 inches is brown sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the subsoil has more clay. In other areas the surface soil has more sand. In a few areas the surface soil is thinner and has a lower content of organic matter because of erosion.

Included with this soil in mapping are small areas of Brainerd and Nokay soils. Brainerd soils are moderately well drained and are in the less sloping areas. Nokay soils are somewhat poorly drained and are in swales and drainageways. Included soils make up about 4 to 14 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Flak soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is medium. The content of organic matter is low or moderately low.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is fairly well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and water erosion are needed. Conservation tillage systems that leave protective amounts of crop residue on the surface, cover crops, crop rotations that include grasses and legumes, terraces and diversions, grassed waterways, and grade stabilization structures help to control water erosion.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling water erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe, and the woodland ordination symbol is 3D.

144C—Flak sandy loam, 8 to 15 percent slopes. This sloping or moderately steep, well drained soil is on crests, ridges, and convex side slopes on drumlins and ground moraines. Individual areas are long and narrow and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 7 inches thick. The subsurface layer is brown sandy loam about 4 inches thick. The subsoil is sandy loam about 35 inches thick. It is dark yellowish brown in the upper part and brown in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the subsoil has more clay. In other areas the surface soil has more sand. In a few places the surface soil is thinner and has a lower content of organic matter because of erosion.

Included with this soil in mapping are small areas of Brainerd and Nokay soils. Brainerd soils are moderately well drained and are lower on the landscape than the Flak soil. Nokay soils are somewhat poorly drained and are in swales and drainageways. Included soils make up about 1 to 5 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Flak soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is medium or rapid. The content of organic matter is low or moderately low.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is fairly well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and water erosion are needed. Cover crops, crop rotations that include grasses and legumes, conservation tillage systems that leave protective amounts of crop residue on the surface, terraces and diversions, grassed waterways, and grade stabilization structures help to prevent excessive erosion.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Water erosion is the main hazard. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe, and the woodland ordination symbol is 3D.

144E—Flak sandy loam, 15 to 25 percent slopes. This moderately steep or steep, well drained soil is on side slopes on drumlins and ground moraines.

Individual areas are long and narrow and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 6 inches thick. The subsoil is sandy loam about 32 inches thick. It is dark yellowish brown in the upper part and brown in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the subsoil has more clay. In other areas the surface soil is thinner and has a lower content of organic matter because of erosion.

Included with this soil in mapping are small areas of the moderately well drained Brainerd soils on side slopes and in swales. These soils make up about 1 to 5 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Flak soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is rapid. The content of organic matter is low or moderately low.

Most areas are used as cropland. Some areas are used for hay or pasture. This soil is generally unsuited to cultivated crops because of the hazard of water erosion.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, crownvetch, smooth bromegrass, switchgrass, and big bluestem. Overgrazing or grazing when the soil is wet causes excessive runoff and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Most stands are mixed northern red oak and quaking aspen. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Operating heavy machinery on the contour rather than up and down the slope minimizes the formation of channels that concentrate runoff and thus helps to control erosion. Equipment should be used with caution on the steep slopes. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. The slope limits the effectiveness of the windbreaks. Water erosion is a severe hazard unless most of the site is kept vegetated. Site preparation should be limited to an area of no more than 2 feet from where the tree or shrub is to be planted. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIe, and the woodland ordination symbol is 3R.

152B—Milaca fine sandy loam, 4 to 8 percent slopes. This gently sloping or sloping, well drained soil is on crests and side slopes on drumlins and moraines. Individual areas are long and narrow or irregular in shape and range from 5 to 60 acres in size.

Typically, the surface layer is very dark gray fine sandy loam about 5 inches thick. The subsurface layer is about 18 inches thick. It is brown fine sandy loam in the upper part and brown gravelly fine sandy loam in the lower part. The subsoil is gravelly sandy loam about 13 inches thick. It is reddish brown in the upper part and dark reddish brown in the lower part. The underlying material to a depth of about 60 inches is reddish brown sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the surface soil has more sand. In other areas the subsoil has more clay. In some places the surface soil is thinner and has a lower content of organic matter because of erosion. In other places it is very stony.

Included with this soil in mapping are small areas of Mora and Ronneby soils. Mora soils are moderately well drained and are in the less sloping areas. Ronneby soils are somewhat poorly drained and are in swales and drainageways. Included soils make up about 3 to 14 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Milaca soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is medium. The content of organic matter is low or moderately low.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and erosion are needed. Conservation tillage systems that leave protective amounts of crop residue on the surface, cover crops, crop rotations that include grasses and legumes, terraces and diversions, grassed waterways, and grade stabilization structures help to control water erosion.

This soil is fairly well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling water erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing

height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe, and the woodland ordination symbol is 5D.

152C—Milaca fine sandy loam, 8 to 15 percent slopes. This sloping or moderately steep, well drained soil is on crests, ridges, and convex side slopes on drumlins and moraines. Individual areas are long and narrow and range from 5 to 30 acres in size.

Typically, the surface layer is black fine sandy loam about 4 inches thick. The subsurface layer is sandy loam about 8 inches thick. It is dark grayish brown in the upper part and brown in the lower part. The subsoil is reddish brown sandy loam about 26 inches thick. The underlying material to a depth of about 60 inches is reddish brown sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the surface soil has more sand. In other areas the subsoil has more clay. In a few areas the surface soil is thinner and has a lower content of organic matter because of erosion. In places it is very stony.

Included with this soil in mapping are small areas of Mora and Ronneby soils. Mora soils are moderately well drained and are in the less sloping areas. Ronneby soils are somewhat poorly drained and are in swales and drainageways. Included soils make up about 3 to 8 percent of the unit.

The permeability is moderate or moderately rapid in the upper part of the Milaca soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is medium or rapid. The content of organic matter is low or moderately low.

Most areas are used as woodland. Some areas are used for cropland, hay, or pasture.

This soil is fairly well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and erosion are needed. Cover crops, crop rotations that include grasses and legumes, conservation tillage systems that leave protective amounts of crop residue on the surface, terraces and diversions, grassed waterways, and grade stabilization structures help to prevent excessive erosion.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Water erosion is the main hazard. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe, and the woodland ordination symbol is 5D.

155B—Chetek sandy loam, 2 to 8 percent slopes. This gently undulating or rolling, somewhat excessively drained soil is on knolls and side slopes on outwash plains, moraines, and stream terraces. Individual areas are irregular in shape and range from 5 to more than 50 acres in size.

Typically, the surface layer is dark grayish brown sandy loam about 6 inches thick. The subsurface layer is brown sandy loam about 4 inches thick. The subsoil is sandy loam about 10 inches thick. It is dark yellowish brown in the upper part and brown in the lower part. The underlying material to a depth of about 60 inches is brown gravelly sand. In some areas the surface soil and subsoil are thicker.

Included with this soil in mapping are small areas of Emmert, Mahtomedi, Oesterle, and Pierz soils. Emmert, Mahtomedi, and Pierz soils are in landscape positions similar to those of the Chetek soil. Emmert and Mahtomedi soils do not have a loamy surface layer. Oesterle soils are somewhat poorly drained and are in swales. Pierz soils are well drained. Included soils make up about 3 to 8 percent of the unit.

Permeability is moderately rapid in the upper part of

the Chetek soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is moderately low or low.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is fairly well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and erosion are needed. Cover crops, crop rotations that include grasses and legumes, conservation tillage systems that leave protective amounts of crop residue on the surface, terraces and diversions, grassed waterways, and grade stabilization structures help to prevent excessive erosion.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Water erosion is the main hazard. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall. The hazard of erosion is generally slight in the nearly level areas.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe, and the woodland ordination symbol is 6A.

155C—Chetek sandy loam, 8 to 15 percent slopes. This rolling or hilly, somewhat excessively drained soil is on knolls and convex side slopes on outwash plains, moraines, and stream terraces. Individual areas are irregular in shape and range from 5 to 15 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 6 inches thick. The subsurface layer is brown sandy loam about 4 inches thick. The subsoil is about 8 inches thick. It is reddish brown sandy loam in the upper part and reddish brown gravelly sandy loam in the lower part. The underlying material to a depth of about 60 inches is brown gravelly sand. In some areas the surface soil is thinner and has a lower content of organic matter because of erosion.

Included with this soil in mapping are Emmert and Mahtomedi soils. These soils do not have a loamy surface layer. They are in landscape positions similar to those of the Chetek soil. Included soils make up about 3 to 8 percent of the unit.

Permeability is moderately rapid in the upper part of the Chetek soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is medium or rapid. The content of organic matter is moderately low or moderate.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is poorly suited to cultivated crops and small grain. Conservation practices that help to control surface runoff and water erosion are needed. Cover crops, crop rotations that include grasses and legumes, conservation tillage systems that leave protective amounts of crop residue on the surface, terraces and diversions, grassed waterways, and grade stabilization structures help to control erosion.

This soil is well suited to many grasses and legumes for hay or pasture. Suitable species include alfalfa, smooth bromegrass, and orchardgrass. A cover of grasses and legumes is effective in controlling water erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Cultivation or

applications of herbicide help to remove competing vegetation.

The land capability classification is IVe, and the woodland ordination symbol is 6A.

158B—Zimmerman loamy fine sand, 1 to 4 percent slopes. This nearly level or gently sloping, excessively drained soil is on plane or slightly convex rises on outwash plains and valley trains. Individual areas are irregular in shape and range from 20 to more than 1,000 acres in size.

Typically, the surface layer is black loamy fine sand about 6 inches thick. The subsurface layer is about 13 inches thick. It is dark brown loamy fine sand in the upper part and brown fine sand in the lower part. The subsoil to a depth of about 60 inches is dominantly dark brown and yellowish brown fine sand that has layers of dark yellowish brown loamy fine sand or fine sandy loam.

Included with this soil in mapping are small areas of Isanti and Soderville soils. Isanti soils are poorly drained and very poorly drained and are in depressions. Soderville soils are somewhat poorly drained and are lower on the landscape than the Zimmerman soil. Included soils make up about 5 to 10 percent of the unit.

Permeability is rapid in the Zimmerman soil. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is low or moderately low.

Most areas are used as cropland. Some areas are used for hay or pasture.

This soil is poorly suited to cropland. The main hazards are drought and soil blowing. Cover crops, conservation tillage systems that leave protective amounts of crop residue on the surface, green manure crops, and stripcropping help to conserve soil moisture, control soil blowing, and increase the content of organic matter. Irrigation can help to overcome the droughtiness and thus increase yields.

This soil is fairly well suited to pasture and hay. Drought and soil blowing are hazards. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall. The hazard of erosion is generally slight in the nearly level areas.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs, and the woodland ordination symbol is 3S.

161—Isanti fine sandy loam. This nearly level, poorly drained and very poorly drained soil is in shallow depressions and drainageways on outwash plains and valley trains. It is subject to ponding. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is black, mottled fine sandy loam about 6 inches thick. The subsurface layer also is black, mottled fine sandy loam. It is about 10 inches thick. The subsoil is dark grayish brown, mottled fine sand about 18 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled fine sand. In some areas the soil has more coarse sand.

Included with this soil in mapping are small areas of Markey and Soderville soils. Markey soils have an organic surface layer that is 16 to 50 inches thick. They are in landscape positions similar to those of the Isanti soil. Soderville soils are somewhat poorly drained. They are higher on the landscape than the Isanti soil. Included soils make up about 5 to 14 percent of the unit.

Permeability is rapid in the Isanti soil. The available water capacity is low. Surface runoff is slow or ponded. The content of organic matter is moderate to very high. The seasonal high water table is within a depth of 2 feet.

Most of the acreage is idle land. Some areas are used for hay or pasture.

This soil is generally unsuited to cultivated crops, hay, and pasture because of the wetness. Some low areas of this soil or some areas that lack suitable outlets for drainage systems may be difficult to drain.

Overgrazing when the soil is wet causes surface compaction. Proper stocking rates, pasture rotation, deferment of grazing until grasses reach a minimum

grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the poor drainage. Spring planting may be delayed because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is Vw. No woodland ordination symbol is assigned.

163B—Brainerd sandy loam, 1 to 4 percent slopes. This nearly level or gently sloping, moderately well drained soil is on crests and side slopes on drumlins and ground moraines. Individual areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 6 inches thick. The subsurface layer is brown, mottled sandy loam about 5 inches thick. The subsoil is brown, mottled sandy loam about 30 inches thick. The underlying material to a depth of about 60 inches is brown, mottled sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the subsoil has more clay. In other areas the surface soil has more sand. In some places the surface soil is thinner and has a lower content of organic matter because of erosion. In other places it is very stony.

Included with this soil in mapping are small areas of Flak, Nokay, and Parent soils. Flak soils are well drained and are in landscape positions higher than those of the Brainerd soil. Nokay soils are somewhat poorly drained and are slightly lower on the landscape than the Brainerd soil. Parent soils are poorly drained and are lower on the landscape than the Brainerd soil. Included soils make up about 5 to 14 percent of the unit.

Permeability is moderately rapid or moderate in the upper part of the Brainerd soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is low to moderate. A perched water table is at a depth of 1.5 to 2.5 feet.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and water erosion are needed. Conservation tillage systems that leave protective amounts of crop residue on the surface, cover crops, crop rotations that include grasses and legumes, terraces and diversions, grassed waterways, and grade stabilization structures help to control water erosion.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling water erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Most stands are mixed northern red oak and quaking aspen. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. This soil is wet in the spring and after heavy rainfall because of the perched water table. The wetness limits the ability of the soil to support heavy machinery. Operating machinery only during dry periods minimizes compaction and increases the seedling survival rate. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIe, and the woodland ordination symbol is 4A.

164B—Mora fine sandy loam, 1 to 4 percent slopes. This nearly level or gently sloping, moderately well drained soil is on crests and side slopes on moraines and drumlins. Individual areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the surface layer is black fine sandy loam about 5 inches thick. The subsurface layer is brown fine sandy loam about 6 inches thick. The subsoil is mottled fine sandy loam about 33 inches thick. It is brown in the upper part and yellowish red in the lower part. The underlying material to a depth of about 60 inches is dark reddish brown, mottled sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the subsoil and underlying material have more clay. In other areas the surface soil is thinner and has a lower content of organic matter because of erosion. In a few places it is very stony.

Included with this soil in mapping are small areas of Milaca, Parent, and Ronneby soils. Milaca soils are well drained and are on more convex rises. Parent soils are

poorly drained and are in concave areas and drainageways. Ronneby soils are somewhat poorly drained and are in slight swales and on side slopes. Included soils make up about 2 to 14 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Mora soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is low to moderate. A perched water table is at a depth of 2 to 3 feet.

Most areas are used as woodland. Some areas are used for hay, pasture, or cropland.

This soil is well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and erosion are needed. Conservation tillage systems that leave protective amounts of crop residue on the surface, cover crops, crop rotations that include grasses and legumes, terraces and diversions, grassed waterways, and grade stabilization structures help to control erosion.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Most stands are mixed northern red oak and quaking aspen. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. This soil is wet in the spring and after heavy rainfall because of the perched water table. The wetness limits the ability of the soil to support heavy machinery. Operating machinery only during dry periods minimizes compaction and increases the seedling survival rate. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIe, and the woodland ordination symbol is 5D.

165—Parent loam. This nearly level, poorly drained soil is on broad flats and in swales or drainageways on moraines. Individual areas are irregular in shape and range from 10 to 50 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark gray, mottled loam about 5 inches thick. The subsoil is about 25 inches thick. In sequence downward it is dark grayish brown, mottled loam; grayish brown, mottled sandy loam; and brown, mottled sandy loam. The underlying material to a depth of about 60 inches is brown, mottled sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the surface soil and subsoil have more sand. In other areas the surface soil is very stony.

Included with this soil in mapping are small areas of Nokay and Prebish soils. Nokay soils are somewhat poorly drained and are on slightly convex rises. Prebish soils are very poorly drained and are in shallow depressions. Included soils make up about 3 to 8 percent of the unit.

Permeability is moderate in the upper part of the Parent soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is slow. The content of organic matter is high or very high. The water table is at a depth of 0.5 foot to 2.5 feet.

Most areas are used for pasture or hay. Some areas are used for cropland.

This soil is fairly well suited to cultivated crops and small grain. Wetness is the main limitation. Open ditches, subsurface drains, or surface drains help to remove excess water. Some low areas of this soil or some areas that lack suitable outlets for drainage systems may be difficult to drain.

This soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, or creeping foxtail for hay or pasture. The species selected should be those that are tolerant of wetness. If this soil is used for pasture, the major concerns are overgrazing or grazing when the soil is wet. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the poor drainage. Spring planting may be delayed because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIw. No woodland ordination symbol is assigned.

166—Ronneby loam. This nearly level, somewhat poorly drained soil is on side slopes, on broad flats, and

in swales on ground moraines and drumlins. Individual areas are irregular in shape and range from 20 to 80 acres in size.

Typically, the surface layer is black loam about 5 inches thick. The subsurface layer is dark grayish brown, mottled fine sandy loam about 6 inches thick. The subsoil is mottled sandy loam about 34 inches thick. In sequence downward it is brown, reddish brown, and dark reddish brown. The underlying material to a depth of about 60 inches is dark reddish brown sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the surface soil is very stony.

Included with this soil in mapping are small areas of Mora and Parent soils. Mora soils are moderately well drained and are in the more convex landscape positions. Parent soils are poorly drained and are in swales. Included soils make up about 4 to 12 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Ronneby soil and slow or very slow in the lower part. The available water capacity is moderate. Surface runoff is slow. The content of organic matter is moderate or high. A perched water table is at a depth of 1.5 to 3.0 feet.

Most areas are used for pasture or hay. Some areas are used as cropland or woodland.

If drained, this soil is well suited to cultivated crops and small grain. Wetness is the main limitation. Open ditches, subsurface drains, or surface drains help to remove excess water. Conservation tillage systems that leave protective amounts of crop residue on the surface, ridge tillage, and winter cover crops help to maintain or increase the content of organic matter and improve tilth.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Most stands are mixed northern red oak and quaking aspen. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. This soil is wet in the spring and after heavy rainfall because of the perched water table. The wetness limits the ability of the soil to support heavy machinery. Operating machinery only during dry periods minimizes compaction and increases the seedling survival rate. The firm subsoil restricts the rooting depth of some plants. Because of the restricted rooting depth, windthrow is a hazard during storms. This hazard can be overcome by harvest methods that do not isolate the remaining trees or leave them widely spaced.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIw, and the woodland ordination symbol is 4W.

182A—Oesterle sandy loam, 0 to 1 percent slopes. This nearly level, somewhat poorly drained soil is on plane or slightly convex rises on outwash plains and stream terraces. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark brown sandy loam about 6 inches thick. The next 3 inches is grayish brown sandy loam that has tongues of brown sandy loam. The subsoil is brown, mottled sandy loam about 14 inches thick. The underlying material to a depth of about 60 inches is reddish brown very gravelly coarse sand in the upper part and very gravelly sand in the lower part. In the southeast corner of the county, the surface layer is dominantly silt loam.

Included with this soil in mapping are small areas of Chetek, Rosholt, and Warman soils. Chetek soils are somewhat excessively drained. Rosholt soils are well drained. Chetek and Rosholt soils are in the more convex areas of the landscape. Warman soils are very poorly drained and are in swales or shallow depressions. Areas that have a finer textured subsoil in sections 11 and 12 of Richardson township are also included. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Oesterle soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is slow. The content of organic matter is moderate or high. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

If drained, this soil is well suited to cultivated crops and small grain. Wetness is the main limitation. Open ditches, subsurface drains, or surface drains help to remove excess water. Conservation tillage systems that leave protective amounts of crop residue on the surface and winter cover crops help to maintain or increase the content of organic matter and improve tilth.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet

causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to trees that are tolerant of moderate wetness. Red pine, white pine, white spruce, quaking aspen, and northern red oak are the most common species, but conifers are dominant in some areas. Adequate site preparation and control of competing vegetation are necessary before suitable conifers can be established. The wetness limits the ability of the soil to support heavy machinery. Windthrow is a hazard during storms because trees in areas of this soil have a shallow root system. This hazard can be overcome by harvest methods that do not isolate the remaining trees or leave them widely spaced.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIw, and the woodland ordination symbol is 3W.

182B—Oesterle sandy loam, 1 to 3 percent slopes. This nearly level or gently sloping, somewhat poorly drained soil is on slightly convex rises on outwash plains and stream terraces. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The next 7 inches is brown sandy loam that has tongues of dark brown, mottled fine sandy loam. The subsoil is about 10 inches thick. It is dark brown, mottled sandy loam in the upper part and brown very gravelly coarse sandy loam in the lower part. The underlying material to a depth of about 60 inches is brown gravelly coarse sand. In the southeast corner of the county, the surface layer is dominantly silt loam.

Included with this soil in mapping are small areas of Chetek, Rosholt, and Warman soils. Chetek soils are somewhat excessively drained. Rosholt soils are well drained. Chetek and Rosholt soils are in the more convex areas. Warman soils are very poorly drained and are in swales or shallow depressions. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Oesterle soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is moderate or high. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is well suited to cultivated crops and small grain. Erosion is the main hazard. Wetness is a limitation. Open ditches, subsurface drains, or surface drains help to remove excess water. Conservation tillage systems that leave protective amounts of crop residue on the surface and winter cover crops help to prevent excessive water erosion, maintain or increase the content of organic matter, and improve tilth.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, timely deferment of grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to trees that are tolerant of moderate wetness. Red pine, white pine, white spruce, quaking aspen, and northern red oak are the most common species, but conifers are dominant in some areas. Adequate site preparation and control of competing vegetation are necessary before suitable conifers can be established. The wetness limits the ability of the soil to support heavy machinery. Windthrow is a hazard during storms because trees in areas of this soil have a shallow root system. This hazard can be overcome by harvest methods that do not isolate the remaining trees or leave them widely spaced.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIe, and the woodland ordination symbol is 3W.

200B—Holdingford sandy loam, 4 to 8 percent slopes. This gently sloping or sloping, well drained soil is on crests and side slopes on ground moraines. Individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is brown sandy loam about 9 inches thick. The subsoil also is brown sandy loam. It is about 32 inches thick. The lower part is mottled. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the lower part has no free carbonates. In other areas the surface soil is thinner and has a lower content of organic matter because of erosion.

Included with this soil in mapping are small areas of the moderately well drained and somewhat poorly

drained Growton soils in swales and on side slopes. Included soils make up about 9 to 13 percent of the unit.

Permeability is moderate in the Holdingford soil. The available water capacity also is moderate. Surface runoff is medium. The content of organic matter is moderately low or moderate.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is fairly well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and water erosion are needed. Conservation tillage systems that leave protective amounts of crop residue on the surface, cover crops, crop rotations that include grasses and legumes, terraces and diversions, grassed waterways, and grade stabilization structures help to control erosion.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling water erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe, and the woodland ordination symbol is 4A.

200C—Holdingford sandy loam, 8 to 15 percent slopes. This sloping or moderately steep, well drained soil is on crests, ridges, and convex side slopes on ground moraines. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsurface layer is dark yellowish brown sandy loam about 7 inches thick. The subsoil is sandy loam about 23 inches thick. It is yellowish brown in the upper part and brown in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the surface soil is thinner and has a lower content of organic matter because of erosion. In other areas the underlying material has no free carbonates.

Included with this soil in mapping are small areas of the moderately well drained and somewhat poorly drained Growton soils in swales and on side slopes. Included soils make up about 2 to 5 percent of the unit.

Permeability is moderate in the Holdingford soil. The available water capacity also is moderate. Surface runoff is medium or rapid. The content of organic matter is moderately low or moderate.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is fairly well suited to cultivated crops and small grain. Erosion is the main hazard. Conservation practices that help to control surface runoff and water erosion are needed. Crop rotations, conservation tillage systems that leave protective amounts of crop residue on the surface, terraces and diversions, grassed waterways, and grade stabilization structures help to control erosion.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Erosion is the main hazard. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe, and the woodland ordination symbol is 4A.

202—Meehan loamy sand. This nearly level, somewhat poorly drained soil is on broad flats and in swales on outwash plains and stream terraces. Individual areas are irregular in shape and range from 5 to 200 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 7 inches thick. The subsurface layer is dark grayish brown, mottled sand about 6 inches thick. The subsoil is brown, mottled sand about 15 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled coarse sand. In some areas the soil has more fine sand. In other areas the surface layer is thicker.

Included with this soil in mapping are small areas of Isan and Menahga soils. Isan soils are poorly and very poorly drained and are in swales and shallow depressions. Menahga soils are excessively drained and are in the more convex areas. Included soils make up about 3 to 14 percent of the unit.

Permeability is rapid in the Meehan soil. The available water capacity is low. Surface runoff is slow. The content of organic matter is low to moderate. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is poorly suited to cultivated crops and small grain. Wetness and soil blowing are hazards. Open ditches, subsurface drains, or surface drains help to remove excess water. Some low areas of this soil or some areas that lack suitable outlets for drainage systems may be difficult to drain. Windbreaks, conservation tillage systems that leave protective amounts of crop residue on the surface, and cover crops help to control soil blowing.

This soil is fairly well suited to grasses and legumes for hay or pasture. Wetness is a major limitation. The grasses and legumes selected for hay or pasture should be those that are tolerant of wetness. These plants include birdsfoot trefoil, red clover, reed canarygrass, and creeping foxtail. Overgrazing when the soil is wet causes compaction. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is well suited to trees that are tolerant of moderate wetness. Red pine, white pine, white spruce, quaking aspen, and northern red oak are the most common species, but conifers are dominant in some areas. Adequate site preparation and control of competing vegetation are necessary before suitable conifers can be established. The wetness limits the ability of the soil to support heavy machinery. Seedling mortality is high because of the wetness. It can be reduced by planting suitable trees. Windthrow is a hazard during storms because trees in areas of this soil have a shallow root system. This hazard can be overcome by harvest methods that do not isolate the remaining trees or leave them widely spaced.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVw, and the woodland ordination symbol is 6W.

204B—Cushing fine sandy loam, 4 to 8 percent slopes. This undulating or rolling, well drained soil is on knolls and side slopes on moraines. Individual areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the surface layer is black fine sandy loam about 6 inches thick. The subsurface layer is brown fine sandy loam about 6 inches thick. The next 9 inches is brown sandy loam that has tongues of brown fine sandy loam. The subsoil is about 20 inches thick. It is brown sandy clay loam in the upper part and brown, mottled sandy loam in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the subsoil has less clay. In other areas the soil is moderately well drained. In places the surface soil is thinner and has a lower content of organic matter because of erosion.

Included with this soil in mapping are small areas of Alstad and Parent soils. Alstad soils are somewhat poorly drained and are in swales and drainageways. Parent soils are poorly drained and are in drainageways and shallow depressions. Included soils make up about 5 to 14 percent of the unit.

Permeability is moderate in the upper part of the Cushing soil and moderately slow in the lower part. The available water capacity is moderate. Surface runoff is medium. The content of organic matter is moderately low or moderate.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is fairly well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and water erosion are needed. Conservation tillage systems that leave protective amounts of crop residue on the surface, cover crops, crop rotations that include grasses and legumes, terraces and diversions, grassed waterways, and grade stabilization structures help to control erosion.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the

grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Harvesting or planting when the soil is not saturated by heavy spring rains minimizes compaction and helps to maintain the potential for seedling regeneration.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe, and the woodland ordination symbol is 3L.

204C—Cushing fine sandy loam, 8 to 15 percent slopes. This rolling or hilly, well drained soil is on knolls and convex side slopes on moraines. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is black fine sandy loam about 5 inches thick. The subsurface layer is about 14 inches thick. It is brown fine sandy loam in the upper part and brown sandy loam in the lower part. The next 10 inches is brown sandy clay loam that has tongues of brown sandy loam. The subsoil is brown sandy clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the subsoil has less clay. In a few areas the surface soil is thinner and has a lower content of organic matter because of erosion.

Included with this soil in mapping are small areas of the somewhat poorly drained Alstad soils in swales and drainageways. Included soils make up about 0 to 10 percent of the unit.

Permeability is moderate in the upper part of the Cushing soil and moderately slow in the lower part. The available water capacity is moderate. Surface runoff is medium or rapid. The content of organic matter is moderately low or moderate.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is fairly well suited to cultivated crops and small grain. Erosion is the main hazard. Conservation practices that help to control surface runoff and water erosion are needed. Cover crops, crop rotations that include grasses and legumes, conservation tillage systems that leave protective amounts of crop residue on the surface, terraces and diversions, grassed waterways, and grade stabilization structures help to control erosion.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Erosion is the main hazard. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Harvesting or planting when the soil is not saturated by heavy spring rains minimizes compaction and helps to maintain the potential for seedling regeneration.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe, and the woodland ordination symbol is 3L.

204E—Cushing fine sandy loam, 15 to 25 percent slopes. This hilly or steep, well drained soil is on ridges and convex side slopes on moraines. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is very dark gray fine sandy loam about 3 inches thick. The subsurface layer is brown fine sandy loam about 5 inches thick. The next 10 inches is brown fine sandy loam that has tongues of brown loam. The subsoil is brown, firm loam about 26 inches thick. The underlying material to a depth of about 60 inches is brown, firm sandy loam. In some areas the subsoil has less clay. In other areas the surface soil is thinner and has a lower content of organic matter because of erosion.

Included with this soil in mapping are small areas of the somewhat poorly drained Alstad soils in swales. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Cushing soil and moderately slow in the lower part. The

available water capacity is moderate. Surface runoff is rapid. The content of organic matter is moderately low or moderate.

Most areas are used for pasture or hay. Some areas are used as cropland or are wooded.

This soil is generally unsuited to cultivated crops because of the hazard of erosion.

This soil is fairly well suited to grasses and legumes for hay or pasture. Suitable species include alfalfa, crownvetch, smooth bromegrass, switchgrass, and big bluestem. Overgrazing or grazing when the soil is wet causes excessive runoff and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Most stands are mixed northern red oak and quaking aspen. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Operating machinery only during dry periods minimizes soil compaction and increases the seedling survival rate. Operating heavy machinery on the contour rather than up and down the slope minimizes the formation of channels that concentrate runoff and thus helps to control erosion. Equipment should be used with caution on the steep slopes.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings. The slope limits the effectiveness of the windbreaks. Water erosion is a severe hazard unless most of the site is kept vegetated. Adequate site preparation should be limited to an area of no more than 2 feet from where the tree or shrub is to be planted. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIe, and the woodland ordination symbol is 3R.

217—Nokasippi mucky loamy fine sand. This nearly level, very poorly drained soil is in shallow depressions, on flats, and in drainageways on ground moraines and drumlins. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is black, mottled mucky loamy fine sand about 8 inches thick. The subsurface layer is very dark gray, mottled loamy fine sand about 4 inches thick. The subsoil is about 36 inches thick. In sequence downward it is grayish brown, mottled loamy fine sand; grayish brown, mottled sandy loam; and brown, mottled sandy loam. The underlying material to a depth of about 60 inches is brown, mottled sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the surface soil and subsoil have more clay.

Included with this soil in mapping are small areas of Cathro and Watab soils. Cathro soils have an organic surface layer 16 to 50 inches thick and are in landscape positions similar to those of the Nokasippi soil. Watab soils are somewhat poorly drained and are in the more convex areas. Included soils make up about 5 to 14 percent of the unit.

Permeability is rapid in the upper part of the Nokasippi soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is slow to ponded. The content of organic matter is moderately low to very high. The seasonal high water table is at a depth of 1 to 2 feet.

Most of the acreage is idle land. Some areas are used for hay, pasture, or cropland.

This soil is generally unsuited to cultivated crops and small grain. Wetness is the main limitation. Soil blowing is a hazard.

This soil is poorly suited to grasses and legumes for hay or pasture. Wetness is a major limitation. The grasses and legumes selected for hay or pasture should be those that are tolerant of wetness. These plants include birdsfoot trefoil, red clover, reed canarygrass, and creeping foxtail. Overgrazing when the soil is wet causes compaction. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the poor drainage. Spring planting may be delayed because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIw. No woodland ordination symbol is assigned.

218—Watab loamy fine sand. This nearly level, somewhat poorly drained soil is on side slopes, on broad flats, and in swales on drumlins and ground moraines. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown loamy fine sand about 8 inches thick. The subsurface layer is mottled loamy fine sand about 18 inches thick. It is dark grayish brown in the upper part and dark brown in the lower part. The subsoil is about 25 inches thick. In sequence downward it is yellowish

brown, mottled loamy fine sand; brown, mottled fine sandy loam; and brown, mottled sandy loam. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the surface soil and subsoil have more clay.

Included with this soil in mapping are small areas of Nokasippi and Pomroy soils. Nokasippi soils are very poorly drained and are in swales and drainageways. Pomroy soils are well drained and moderately well drained and are on the more convex rises. Included soils make up about 5 to 10 percent of the unit.

The permeability is rapid in the upper part of the Watab soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is slow. The content of organic matter is low or moderately low. A perched water table is at a depth of 1.5 to 3.0 feet.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is fairly well suited to cultivated crops and small grain. Wetness is the main limitation. Soil blowing is a hazard. Open ditches, subsurface drains, or surface drains help to remove excess water. Some low areas of this soil or some areas that lack suitable outlets for drainage systems may be difficult to drain. Conservation tillage systems that leave protective amounts of crop residue on the surface and cover crops help to control soil blowing.

This soil is fairly well suited to birdsfoot trefoil, red clover, reed canarygrass, or creeping foxtail for hay or pasture. The grasses and legumes selected for hay or pasture should be those that are tolerant of wetness. If this soil is used for pasture, the major concerns are overgrazing and grazing when the soil is wet. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Most stands are mixed northern red oak and quaking aspen. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. This soil is wet in the spring and after heavy rainfall because of the perched water table. The wetness limits the ability of the soil to support heavy machinery. Operating machinery only during dry periods minimizes compaction and increases the seedling survival rate. The firm subsoil restricts the rooting depth of some plants. Seedling mortality is high because of the wetness. It can be reduced by planting suitable trees.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIw, and the woodland ordination symbol is 6S.

233A—Growton sandy loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on broad flats, on side slopes, and in swales on ground moraines and drumlins. Individual areas are irregular in shape and range from 5 to 150 acres in size.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsurface layer is brown, mottled sandy loam about 10 inches thick. The subsoil is also brown, mottled sandy loam. It is about 19 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown, mottled sandy loam. In some areas the subsoil has more clay. In other areas the soil is moderately well drained.

Included with this soil in mapping are small areas of Parent and Prebish soils. Parent soils are poorly drained. Prebish soils are very poorly drained. Both soils are in swales, drainageways, and shallow depressions. They make up about 3 to 8 percent of the unit.

Permeability is moderately rapid or moderate in the Growton soil. The available water capacity is moderate. Surface runoff is slow. The content of organic matter is moderately low or moderate. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

If drained, this soil is well suited to cultivated crops and small grain. Wetness is the main limitation. Open ditches, subsurface drains, or surface drains help to remove excess water. Conservation tillage systems that leave protective amounts of crop residue on the surface and cover crops help to maintain or increase the content of organic matter and improve tilth.

This soil is well suited to grasses and legumes for hay or pasture. Wetness is a limitation. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Harvesting or planting when the soil is not

saturated by heavy spring rains minimizes compaction and helps to maintain the potential for seedling regeneration.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIw, and the woodland ordination symbol is 6A.

233B—Growton sandy loam, 2 to 4 percent slopes. This gently sloping, moderately well drained soil is on crests and side slopes on ground moraines and drumlins. Individual areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 9 inches thick. The subsurface layer is brown, mottled sandy loam about 10 inches thick. The subsoil also is brown, mottled sandy loam. It is about 25 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown, mottled sandy loam. In some areas the subsoil has more clay. In other areas the soil is somewhat poorly drained.

Included with this soil in mapping are small areas of Holdingford and Parent soils. Holdingford soils are well drained and are on the more convex rises. Parent soils are poorly drained and are in swales and drainageways. Included soils make up about 3 to 10 percent of the unit.

Permeability is moderately rapid or moderate in the Growton soil. The available water capacity is moderate. Surface runoff is slow or medium. The content of organic matter is moderately low or moderate. The seasonal high water table is at a depth of 3 to 5 feet.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and water erosion are needed. Conservation tillage systems that leave protective amounts of crop residue on the surface, cover crops, crop rotations that include grasses and legumes, terraces and diversions, grassed waterways, and grade stabilization structures help to control erosion.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Harvesting or planting when the soil is not saturated by heavy spring rains minimizes compaction and helps to maintain the potential for seedling regeneration.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIe, and the woodland ordination symbol is 6A.

260—Duelm loamy sand. This nearly level, somewhat poorly drained and moderately well drained soil is on side slopes and on plane or slightly convex rises on outwash plains. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is very dark gray loamy sand about 7 inches thick. The subsurface layer is very dark brown loamy sand about 4 inches thick. The subsoil is about 22 inches thick. It is dark grayish brown and mottled. It is sand in the upper part and coarse sand in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled coarse sand. In some areas the dark surface layer is thinner. In other areas the subsoil and underlying material have more gravel.

Included with this soil in mapping are small areas of Hubbard and Isan soils. Hubbard soils are excessively drained and are on the more convex rises. Isan soils are poorly drained and very poorly drained and are in swales, drainageways, and shallow depressions. Included soils make up about 5 to 14 percent of the unit.

Permeability is rapid in the Duelm soil. The available water capacity is low. Surface runoff is slow. The content of organic matter is moderate or high. The seasonal high water table is at a depth of 2 to 5 feet.

Most areas are used as cropland. Some areas are used for hay or pasture.

This soil is poorly suited to cultivated crops and smal grain. Drought and soil blowing are hazards. Irrigation can help to overcome the droughtiness. Stripcropping, green manure crops, manure, conservation tillage systems that leave protective amounts of crop residue

on the surface, and cover crops help to conserve soil moisture, control soil blowing, and maintain the content of organic matter.

This soil is fairly well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Suitable species include alfalfa, crownvetch, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs. No woodland ordination symbol is assigned.

261—Isan sandy loam. This nearly level, poorly drained and very poorly drained soil is on broad flats and in shallow depressions on outwash plains and valley trains. It is subject to ponding. Individual areas are irregular in shape and range from 15 to 200 acres in size.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is very dark gray, mottled loamy sand about 5 inches thick. The subsoil is dark grayish brown, mottled sand about 12 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled coarse sand. In some areas the surface soil is thinner. In other areas the soil has more fine sand.

Included with this soil in mapping are small areas of Duelm, Markey, and Meehan soils. Duelm soils are somewhat poorly drained and moderately well drained and are on convex rises and side slopes. Markey soils have an organic surface layer 16 to 50 inches thick and are in depressions. Meehan soils are somewhat poorly drained and are on convex rises and side slopes. Included soils make up about 2 to 14 percent of the unit.

Permeability is rapid in the Isan soil. The available water capacity is low. Surface runoff is slow to ponded. The content of organic matter is moderate to very high. The seasonal high water table is at a depth of 0.5 foot to 2.0 feet.

Most of the acreage is idle land. Some areas are used for hay or pasture.

This soil is generally unsuited to cultivated crops, hay, and pasture because of the wetness. Some low areas of this soil or some areas that lack suitable outlets for drainage systems may be difficult to drain.

Overgrazing when the soil is wet causes compaction. Proper stocking rates, pasture rotation, deferment of grazing until grasses reach a minimum grazing height, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the poor drainage. Spring planting may be delayed because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is Vw. No woodland ordination symbol is assigned.

264B—Freeon silt loam, 1 to 4 percent slopes. This nearly level or gently sloping, moderately well drained soil is on crests and side slopes on drumlins and moraines. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsurface layer is brown very fine sandy loam about 8 inches thick. The next 5 inches is brown very fine sandy loam that has tongues of silt loam. The subsoil is about 15 inches thick. It is brown, mottled silt loam in the upper part and brown, mottled loam in the lower part. The underlying material to a depth of about 60 inches is dark reddish brown sandy loam. In some areas the surface soil has more sand.

Included with this soil in mapping are small areas of Freer and Parent soils. Freer soils are somewhat poorly drained and are in swales and on side slopes. Parent soils are poorly drained and are in drainageways and shallow depressions. Included soils make up about 1 to 14 percent of the unit.

Permeability is moderate in the upper part of the Freeon soil and slow or very slow in the lower part. The available water capacity is moderate. Surface runoff is slow or medium. The content of organic matter is moderately low or moderate. A perched water table is at a depth of 2 to 3 feet.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that control surface runoff and water erosion are needed. Conservation tillage systems that leave protective amounts of crop residue on the surface, cover crops, crop rotations that include grasses and legumes, terraces and diversions, grassed waterways, and grade stabilization structures help to control water erosion.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses

and legumes is effective in controlling water erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Most stands are mixed northern red oak and quaking aspen. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. This soil is wet in the spring and after heavy rainfall because of the perched water table. The wetness limits the ability of the soil to support heavy machinery. Operating machinery only during dry periods minimizes compaction and increases the seedling survival rate. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIe, and the woodland ordination symbol is 3D.

265—Soderville loamy fine sand. This nearly level, somewhat poorly drained soil is on side slopes, on broad flats, and in swales on outwash plains. Individual areas are irregular in shape and range from 5 to 80 acres in size.

Typically, the surface layer is very dark grayish brown loamy fine sand about 8 inches thick. The subsurface layer is brown, mottled loamy fine sand about 23 inches thick. The subsoil is about 18 inches thick. It is brown, mottled fine sandy loam in the upper part and brown, mottled loamy fine sand in the lower part. The underlying material to a depth of about 60 inches is pale brown, mottled fine sand. In some areas the subsoil has less clay.

Included with this soil in mapping are small areas of Isanti and Zimmerman soils. Isanti soils are poorly drained and very poorly drained and are in depressions. Zimmerman soils are excessively drained and are on the more convex rises. Included soils make up about 4 to 14 percent of the unit.

Permeability is rapid in the Soderville soil. The available water capacity is low. Surface runoff is slow. The content of organic matter is low or moderately low. The seasonal high water table is at a depth of 2 to 4 feet.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is poorly suited to cultivated crops and small grain. Wetness and soil blowing are hazards. Open ditches, subsurface drains, surface drains, or a combination of these methods help to remove excess water. Some low areas of this soil or some areas that lack suitable outlets for drainage systems may be difficult to drain. Windbreaks and conservation tillage systems that leave protective amounts of crop residue on the surface help to control soil blowing.

This soil is fairly well suited to grasses and legumes for hay or pasture. Wetness is a major limitation. The grasses and legumes selected for hay or pasture should be those that are tolerant of wetness. These plants include birdsfoot trefoil, red clover, reed canarygrass, and creeping foxtail. Overgrazing when the soil is wet causes compaction. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is well suited to trees that are tolerant of moderate wetness. Red pine, white pine, white spruce, aspen, and northern red oak are the most common species, but conifers are dominant in some areas. Adequate site preparation and control of competing vegetation are necessary before suitable conifers can be established. The wetness limits the ability of the soil to support heavy machinery. Seedling mortality is high because of the wetness. It can be reduced by planting suitable species.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVw, and the woodland ordination symbol is 6W.

266—Freer silt loam. This nearly level, somewhat poorly drained soil is on broad flats and in swales on drumlins and moraines. Individual areas are irregular in shape and range from 5 to 90 acres in size.

Typically, the surface layer is black silt loam about 4 inches thick. The subsurface layer is grayish brown, mottled silt loam about 7 inches thick. The next 5 inches is grayish brown, mottled silt loam that has tongues of yellowish brown loam. The subsoil is about 28 inches thick. In sequence downward it is yellowish brown and brown, mottled loam and reddish brown sandy loam. The underlying material to depth of about 60 inches is reddish brown sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the silty surface soil is thinner. In a few places the subsoil has less clay.

Included with this soil in mapping are small areas of Freeon and Parent soils. Freeon soils are moderately well drained and are in the more convex areas and on side slopes. Parent soils are poorly drained and are in swales, drainageways, and shallow depressions. Included soils make up about 5 to 14 percent of the unit.

Permeability is moderate in the upper part of the Freer soil and slow or very slow in the lower part. The available water capacity is low or moderately low. Surface runoff is slow. The content of organic matter is low. A perched water table is at a depth of 1 to 3 feet.

Most areas are used as woodland. Some areas are used for hay, pasture, or woodland.

If drained, this soil is well suited to cultivated crops and small grain. Wetness is the main limitation. Open ditches, subsurface drains, or surface drains help to remove excess water. Conservation tillage systems that leave protective amounts of crop residue on the surface and winter cover crops help to maintain or increase the content of organic matter and improve tilth.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Most stands are mixed northern red oak and quaking aspen. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. This soil is wet in the spring and after heavy rainfall because of the perched water table. The wetness limits the ability of the soil to support heavy machinery. Operating machinery only during dry periods minimizes compaction and increases the seedling survival rate. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIw, and the woodland ordination symbol is 5W.

292—Alstad loam. This nearly level or gently sloping, somewhat poorly drained soil is on side slopes and in swales on uplands. Individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsurface layer is dark grayish brown, mottled loam about 4 inches thick. The next 8 inches is dark grayish brown, mottled loam that has tongues of brown loam. The subsoil is brown, mottled loam about 33 inches thick. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the subsoil has less clay. In other areas the surface soil and subsoil have more sand. In places in the Randall area, the subsoil and underlying material have more clay.

Included with this soil in mapping are small areas of Cushing, Parent, and Prebish soils. Cushing soils are well drained and are on the more convex rises. Parent soils are poorly drained and are in drainageways and shallow depressions. Prebish soils are very poorly drained and are in depressions. Included soils make up about 5 to 14 percent of the unit.

Permeability is moderate in the upper part of the Alstad soil and moderately slow in the lower part. The available water capacity is high. Surface runoff is slow or medium. The content of organic matter is moderate or high. The water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

If drained, this soil is well suited to cultivated crops and small grain. Wetness is the main limitation. Open ditches, subsurface drains, or surface drains help to remove excess water. Conservation tillage systems that leave protective amounts of crop residue on the surface, ridge tillage, and winter cover crops help to maintain or increase the content of organic matter and improve tilth.

This soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing and grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the predominant species, but some ash, elm, maple, paper birch, and spruce are in most stands. Northern red oak and quaking aspen typically have good potential for natural regeneration of healthy trees. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Harvesting or planting when the soil is not saturated by heavy spring rains minimizes compaction and helps to maintain the potential for seedling regeneration. Windthrow is a hazard during storms because trees in areas of this soil have a shallow root system. This hazard can be overcome by harvest

methods that do not isolate the remaining trees or leave them widely spaced.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIe, and the woodland ordination symbol is 4W.

302B—Rosholt silt loam, 1 to 4 percent slopes. This nearly level or gently sloping, well drained soil is on crests and side slopes on outwash plains. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is brown silt loam about 10 inches thick. The next 6 inches is brown silt loam that has tongues of brown loam. The subsoil is about 10 inches thick. It is brown loam in the upper part and brown sandy loam in the lower part. The underlying material to a depth of about 60 inches is brown very gravelly coarse sand. In some areas the subsoil has more clay.

Included with this soil in mapping are small areas of Oesterle and Mahtomedi soils. Oesterle soils are somewhat poorly drained and are in slight swales and on side slopes. Mahtomedi soils are sandy throughout and excessively drained. They are in landscape positions similar to those of the Rosholt soil. Areas that have a finer textured subsoil in sections 11 and 12 of Richardson township are also included. Included soils make up about 5 to 14 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Rosholt soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is moderately low or moderate.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that control surface runoff and water erosion are needed. Conservation tillage systems that leave protective amounts of crop residue on the surface, cover crops, crop rotations that include grasses and legumes, terraces and diversions, grassed waterways, and grade stabilization structures help to control erosion.

This soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Seedling mortality can be reduced by selecting good-quality planting stock and by planting early in the spring, when the amount of moisture is highest.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIe, and the woodland ordination symbol is 3L.

325—Prebish loam. This nearly level, very poorly drained soil is on flats, in drainageways, and in shallow depressions on till plains and moraines. It is subject to ponding. Individual areas are irregular in shape and range from 10 to 80 acres in size.

Typically, the surface soil is black loam about 7 inches thick. The subsurface layer is black, mottled loam about 6 inches thick. The subsoil is grayish brown, mottled fine sandy loam about 29 inches thick. The underlying material to a depth of about 60 inches is brown, mottled sandy loam. In some areas the surface soil has more sand.

Included with this soil in mapping are small areas of Cathro, Nokay, and Parent soils. Cathro soils have at least 16 inches of organic material. Parent soils are poorly drained. Cathro and Parent soils are in landscape positions similar to those of the Prebish soil. Nokay soils are somewhat poorly drained and are on the more convex rises. Included soils make up about 5 to 11 percent of the unit.

Permeability is moderately slow or moderate in the upper part of the Prebish soil and moderately slow in the lower part. The available water capacity is moderate. Surface runoff is very slow or ponded. The content of organic matter is high or very high. The seasonal high water table is 1 foot above to 1 foot below the surface.

Most of the acreage is idle land. Some areas are used for hay or pasture.

This soil is generally unsuited to cultivated crops, hay, and pasture because of the wetness.

Overgrazing when the soil is wet causes compaction. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to

keep the pasture in good condition.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the poor drainage. Spring planting may be delayed because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIw, and the woodland ordination symbol is 3W.

328B—Sartell loamy fine sand, 1 to 6 percent slopes. This nearly level or gently sloping, excessively drained soil is on crests and side slopes on outwash plains and valley trains. Individual areas are irregular in shape and range from 5 to more than 50 acres in size.

Typically, the surface layer is very dark grayish brown loamy fine sand about 7 inches thick. The subsoil is fine sand about 32 inches thick. In sequence downward it is brown, dark yellowish brown, and brown. The underlying material to a depth of about 60 inches is yellowish brown fine sand. In some areas the subsoil or underlying material has more clay. In other areas the soil has more medium and coarse sand.

Included with this soil in mapping are small areas of Isan and Meehan soils. Isan soils are poorly drained and very poorly drained and are in shallow depressions and drainageways. Meehan soils are somewhat poorly drained and are on side slopes and in swales. Included soils make up about 5 to 14 percent of the unit.

Permeability is rapid in the Sartell soil. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is low or moderately low.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is poorly suited to cultivated crops and small grain. Drought and soil blowing are hazards. Planting short-season varieties or irrigating helps to overcome the droughtiness. Cover crops, windbreaks, conservation tillage systems that leave protective amounts of crop residue on the surface, green manure crops, and stripcropping help to conserve soil moisture, control soil blowing, and increase the content of organic matter.

This soil is fairly well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. In areas where the protective cover has been disturbed, soil blowing can occur. The hazard of water erosion is generally slight. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs, and the woodland ordination symbol is 7S.

328C—Sartell loamy fine sand, 6 to 12 percent slopes. This sloping, excessively drained soil is on crests, ridges, and convex side slopes on outwash plains and valley trains. Individual areas are irregular in shape and range from 5 to 30 acres in size.

Typically, the surface layer is very dark gray loamy fine sand about 3 inches thick. The subsoil is fine sand about 25 inches thick. In sequence downward it is dark brown, brown, and dark yellowish brown. The underlying material to a depth of about 60 inches is brown fine sand. In some areas the soil has more medium and coarse sand. In other areas the subsoil or underlying material has more clay.

Included with this soil in mapping are small areas of the somewhat poorly drained Meehan soils. These soils are on side slopes and in swales. They make up about 5 to 14 percent of the unit.

Permeability is rapid in the Sartell soil. The available water capacity is low. Surface runoff is medium or rapid. The content of organic matter is low or moderately low.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is generally unsuited to cultivated crops and poorly suited to hay and pasture because of droughtiness.

In areas used for pasture or hay, the droughtiness is a major hazard. Suitable species include alfalfa, crownvetch, smooth bromegrass, big bluestem, little bluestem, and sideoats grama. Pasture rotation, weed control, deferment of grazing until the grasses reach a minimum grazing height, and applications of fertilizer

help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIs, and the woodland ordination symbol is 7S.

337—Warman loam. This nearly level, very poorly drained soil is in shallow depressions, flats, and drainageways on outwash plains. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is very dark gray loam about 9 inches thick. The subsurface layer is very dark grayish brown very fine sandy loam about 3 inches thick. The subsoil is about 21 inches thick. In sequence downward it is very dark grayish brown silt loam, grayish brown fine sandy loam, and grayish brown loam. The underlying material to a depth of about 60 inches is dark yellowish brown sand. In some areas the subsoil has less clay.

Included with this soil in mapping are small areas of Markey and Oesterle soils. Markey soils have an organic surface layer 16 to 50 inches thick and are lower on the landscape than the Warman soil. Oesterle soils are somewhat poorly drained and are slightly higher on the landscape than the Warman soil. Included soils make up about 5 to 14 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Warman soil and rapid or very rapid in the lower part. The available water capacity is moderate. Surface runoff is very slow or ponded. The content of organic matter is high or very high. The seasonal high water table is 2 feet above to 1 foot below the surface.

Most of the acreage is idle land. Some areas are used for hay, pasture, or woodland.

This soil is generally unsuited to cultivated crops, hay, and pasture because of the wetness.

Overgrazing when the soil is wet causes compaction. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is suited to trees that are tolerant of prolonged wetness. Growth rates of trees are slow. The wetness is a limitation affecting the harvesting and planting of trees. Clearcutting helps to maintain the potential for seedling regeneration and helps to overcome the hazard of windthrow. Seedling mortality is high because of the wetness. It can be reduced by planting suitable species.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is severe because of very poor drainage. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIw, and the woodland ordination symbol is 7W.

341A—Arvilla sandy loam, 0 to 2 percent slopes. This nearly level, somewhat excessively drained soil is on plane or slightly convex rises on stream terraces and outwash plains. Individual areas are irregular in shape and range from 5 to 400 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsoil is dark brown sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown and dark grayish brown gravelly coarse sand. In some areas the surface layer has free carbonates. In other areas the subsoil has less clay.

Included with this soil in mapping are small areas of Forada and Osakis soils. Forada soils are poorly drained and are in drainageways and shallow depressions. Osakis soils are moderately well drained and are in slightly concave areas and drainageways. Included soils make up about 1 to 5 percent of the unit.

Permeability is moderately rapid in the upper part of the Arvilla soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is slow. The content of organic matter is moderately low or moderate.

Most areas are used as cropland. Some areas are used for hay or pasture.

This soil is fairly well suited to cultivated crops and small grain. Drought and soil blowing are hazards. Irrigation can help to overcome the droughtiness. Stripcropping, green manure crops, manure, conservation tillage systems that leave protective amounts of crop residue on the surface, and cover

crops help to conserve soil moisture, control soil blowing, and maintain the content of organic matter.

This soil is well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Suitable species include alfalfa, crownvetch, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIs. No woodland ordination symbol is assigned.

341B—Arvilla sandy loam, 2 to 6 percent slopes. This gently sloping, somewhat excessively drained soil is on crests and side slopes on stream terraces and outwash plains. Individual areas are irregular in shape and range from 5 to 200 acres in size.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsoil is brown sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is brown gravelly coarse sand. In some areas the surface layer has free carbonates. In other areas the subsoil has less clay.

Included with this soil in mapping are small areas of Forada and Osakis soils. Forada soils are poorly drained and are in drainageways and shallow depressions. Osakis soils are moderately well drained and are in slightly concave areas and drainageways. Included soils make up about 1 to 5 percent of the unit.

Permeability is moderately rapid in the upper part of the Arvilla soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is moderately low or moderate.

Most areas are used as cropland. Some areas are used for hay or pasture.

This soil is fairly well suited to cultivated crops and small grain. Drought and soil blowing are hazards. Irrigation can help to overcome the droughtiness. Stripcropping, green manure crops, manure, conservation tillage systems that leave protective amounts of crop residue on the surface, and cover crops help to conserve soil moisture, control soil blowing, and maintain the content of organic matter.

This soil is well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. In the steeper areas, water erosion also is a hazard. Suitable species include alfalfa, crownvetch, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe. No woodland ordination symbol is assigned.

375—Forada loam. This nearly level, poorly drained soil is on broad flats, in drainageways, and in shallow depressions on outwash plains and valley trains. Individual areas are irregular in shape and range from 5 to more than 200 acres in size.

Typically, the surface layer is black loam about 12 inches thick. The subsurface layer is very dark gray, mottled sandy loam about 4 inches thick. The subsoil is mottled. It is about 19 inches thick. It is brown sandy loam in the upper part and grayish brown loamy coarse sand in the lower part. The upper part of the underlying material is grayish brown coarse sand. The lower part to a depth of about 60 inches is light olive brown sand. In some areas the subsoil has more clay. In other areas the soil is very poorly drained and is in depressions.

Included with this soil in mapping are small areas of Markey and Osakis soils. Markey soils have an organic surface layer 16 to 50 inches thick and are in landscape positions similar to those of the Forada soil. Osakis soils are moderately well drained and are in the more convex areas. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Forada soil and rapid in the lower part. The available water capacity is low. Surface runoff is slow. The content of organic matter is high or very high. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used for pasture or hay. Some of the acreage is idle land.

If drained, this soil is well suited to cultivated crops, hay, or pasture. Wetness is a limitation. Soil blowing is a hazard. Open ditches, tile drains, surface drains, or a

combination of these methods help to remove excess water. Some low areas of this soil or some areas that lack suitable outlets for drainage systems may be difficult to drain. Windbreaks, conservation tillage systems that leave protective amounts of crop residue on the surface, and cover crops help to control soil blowing.

This soil is fairly well suited to grasses and legumes for hay or pasture. Wetness is the major limitation. The grasses and legumes selected for hay or pasture should be those that are tolerant of wetness. These plants include birdsfoot trefoil, red clover, reed canarygrass, and creeping foxtail. Overgrazing when the soil is wet causes compaction. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the poor drainage. Spring planting may be delayed because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIw. No woodland ordination symbol is assigned.

413—Osakis loam. This nearly level, moderately well drained soil is on plane or slightly convex rises on outwash plains. Individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsoil is about 13 inches thick. It is dark brown, mottled loam in the upper part and brown, mottled sand in the lower part. The upper part of the underlying material is grayish brown gravelly sand. The lower part to a depth of about 60 inches is dark grayish brown gravelly coarse sand. In some areas the surface soil is thinner. In other areas the depth to carbonates is more than 25 inches.

Included with this soil in mapping are small areas of Arvilla and Forada soils. Arvilla soils are somewhat excessively drained and are higher on the landscape than the Osakis soil. Forada soils are poorly drained and very poorly drained and are in drainageways and shallow depressions. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Osakis soil and rapid in the lower part. The available water capacity is low. Surface runoff is slow. The content of organic matter is moderate or high. The seasonal high water table is at a depth of 3 to 6 feet.

Most areas are used as cropland. Some areas are used for hay or pasture.

This soil is fairly well suited to cultivated crops and small grain. Drought and soil blowing are hazards. Irrigation can help to overcome the droughtiness. Stripcropping, green manure crops, manure, conservation tillage systems that leave protective amounts of crop residue on the surface, and cover crops help to conserve soil moisture, control soil blowing, and maintain the content of organic matter.

This soil is well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, deferment of grazing during dry periods, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIs. No woodland ordination symbol is assigned.

454B—Mahtomedi loamy sand, 2 to 8 percent slopes. This gently undulating or rolling, excessively drained soil is on knolls and side slopes on moraines and outwash plains. Individual areas are irregular in shape and range from 15 to 200 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 7 inches thick. The subsurface layer is brown loamy sand about 5 inches thick. The subsoil is about 25 inches thick. It is dark yellowish brown gravelly coarse sand in the upper part and yellowish brown gravelly sand in the lower part. The underlying material to a depth of about 60 inches is brown gravelly sand. In some areas the subsoil has more clay.

Included with this soil in mapping are small areas of Emmert, Meehan, and Menahga soils. Emmert soils have more gravel than the Mahtomedi soil. Meehan soils are somewhat poorly drained and are lower on the landscape than the Mahtomedi soil. Menahga soils have less gravel than the Mahtomedi soil. Emmert and Menahga soils are in landscape positions similar to those of the Mahtomedi soil. Included soils make up about 1 to 8 percent of the unit.

Permeability is rapid in the Mahtomedi soil. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is low or moderately low.

Most areas are used as woodland. Some areas are used for hay, pasture, or cropland.

This soil is poorly suited to cultivated crops and small

grain. Drought and soil blowing are hazards. Planting short-season varieties or irrigating helps to overcome the droughtiness. Cover crops, windbreaks, conservation tillage systems that leave protective amounts of crop residue on the surface, green manure crops, and stripcropping help to conserve soil moisture, control soil blowing, and increase the content of organic matter.

This soil is fairly well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall. The hazard of erosion is generally slight in the nearly level areas.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs, and the woodland ordination symbol is 2S.

454C—Mahtomedi loamy sand, 8 to 15 percent slopes. This rolling or hilly, excessively drained soil is on knolls and convex side slopes on moraines and outwash plains. Individual areas are irregular in shape and range from 5 to 80 acres in size.

Typically, the surface layer is very dark gray loamy sand about 5 inches thick. The subsurface layer is brown sand about 5 inches thick. The subsoil is about 25 inches thick. It is brown gravelly sand in the upper part and dark yellowish brown coarse sand in the lower part. The underlying material to a depth of about 60 inches is yellowish brown gravelly sand. In some areas the subsoil has more clay.

Included with this soil in mapping are small areas of Emmert and Menahga soils. Emmert soils have more gravel than the Mahtomedi soil, and Menahga soils have less gravel. Emmert and Menahga soils are in landscape positions similar to those of the Mahtomedi soil. Included soils make up about 1 to 8 percent of the unit.

Permeability is rapid in the Mahtomedi soil. The available water capacity is low. Surface runoff is medium or rapid. The content of organic matter is low or moderately low.

Most areas are used as woodland. Some areas are used for hay, pasture, or cropland.

This soil is poorly suited to cultivated crops and small grain. Drought and soil blowing are hazards. Cover crops, windbreaks, conservation tillage systems that leave protective amounts of crop residue on the surface, green manure crops, and stripcropping help to conserve soil moisture, control soil blowing, and increase the content of organic matter.

This soil is fairly well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in water erosion and soil blowing. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. The slope limits the use of equipment. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall. Establishing roads and trails on the contour helps to control erosion.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs, and the woodland ordination symbol is 2S.

454E—Mahtomedi loamy sand, 15 to 25 percent slopes. This hilly or steep, excessively drained soil is on ridges and convex side slopes on moraines and outwash plains. Individual areas are irregular in shape or long and narrow and range from 15 to 100 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 4 inches thick. The subsoil is about 22 inches thick. It is brown coarse sand in the upper part and brown gravelly coarse sand in the lower part. The underlying material to a depth of about 60 inches is dark yellowish brown coarse sand. In some areas the subsoil has more clay.

Included with this soil in mapping are small areas of Emmert and Menahga soils. Emmert soils have more gravel than the Mahtomedi soil, and Menahga soils have less gravel. Emmert and Menahga soils are in landscape positions similar to those of the Mahtomedi soil. Included soils make up about 1 to 5 percent of the unit.

Permeability is rapid in the Mahtomedi soil. The available water capacity is low. Surface runoff is rapid. The content of organic matter is low or moderately low.

Most areas are used as woodland. This soil is generally unsuited to cropland, hay, and pasture.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall. Operating heavy machinery on the contour rather than up and down the slope minimizes the formation of channels that concentrate runoff and thus helps to control erosion. Equipment should be used with caution on the steep slopes.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. The slope limits the effectiveness of the windbreaks. Seedling mortality is moderate because of the low available water capacity. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Water erosion is a severe hazard unless most of the site is kept vegetated. Site preparation should be limited to an area of no more than 2 feet from where the tree or shrub is to be planted. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIs, and the woodland ordination symbol is 2R.

454F—Mahtomedi loamy sand, 25 to 45 percent slopes. This very steep, excessively drained soil is on ridges, bluffs, and valley walls on moraines and outwash plains. Individual areas are irregular in shape or long and narrow and range from 10 to 30 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 3 inches thick. The subsurface layer is brown sand about 3 inches thick. The subsoil is also brown sand. It is about 18 inches thick. The underlying material to a depth of about 60 inches is brown gravelly sand. In some areas the subsoil has more clay.

Included with this soil in mapping are small areas of Emmert and Menahga soils. Emmert soils have more gravel than the Mahtomedi soil, and Menahga soils have less gravel. Emmert and Menahga soils are in landscape positions similar to those of the Mahtomedi soil. Included soils make up about 1 to 5 percent of the unit.

Permeability is rapid in the Mahtomedi soil. The available water capacity is low. Surface runoff is rapid. The content of organic matter is low or moderately low.

Most areas are used as woodland. This soil is generally unsuited to cropland, hay, and pasture because of the droughtiness and the slope.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Harvesting that minimizes soil disturbance is necessary. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall. The hazard of erosion is generally moderate or severe. Equipment should be used with caution on the steep slopes.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. The slope limits the effectiveness of the windbreaks. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Water erosion is a severe hazard unless most of the site is kept vegetated. Adequate site preparation should be limited to an area of no more than 2 feet from where

the tree or shrub is to be planted. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIIs, and the woodland ordination symbol is 2R.

458A—Menahga loamy sand, 0 to 2 percent slopes. This nearly level, excessively drained soil is on plane or slightly convex rises on outwash plains and valley trains. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is very dark gray loamy sand about 3 inches thick. The subsoil is brown sand about 21 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown sand. In some areas the surface layer is thicker. In other areas the subsoil has more clay.

Included with this soil in mapping are small areas of Emmert, Mahtomedi, and Meehan soils. Emmert and Mahtomedi soils have more gravel than the Menahga soil. They are in landscape positions similar to those of the Menahga soil. Meehan soils are somewhat poorly drained and are in swales and on side slopes. Included soils make up about 1 to 10 percent of the unit.

Permeability is rapid in the Menahga soil. The available water capacity is low. Surface runoff is slow. The content of organic matter is low or moderately low.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is poorly suited to cultivated crops and small grain. Drought and soil blowing are hazards. Planting short-season varieties or irrigating helps to overcome the droughtiness. Cover crops, windbreaks, conservation tillage systems that leave protective amounts of crop residue on the surface, green manure crops, and stripcropping help to conserve soil moisture, control soil blowing, and increase the content of organic matter.

This soil is fairly well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can result in erosion and soil blowing. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. In areas where the protective cover has been disturbed, soil blowing can occur. The hazard of water erosion is generally slight. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs, and the woodland ordination symbol is 4S.

458B—Menahga loamy sand, 2 to 8 percent slopes. This gently undulating or rolling, excessively drained soil is on knolls and side slopes on outwash plains and valley trains. Individual areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 3 inches thick. The subsurface layer is grayish brown loamy sand about 5 inches thick. The subsoil is sand about 26 inches thick. It is brown in the upper part and yellowish brown in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown sand. In some areas the surface layer is thicker. In other areas the subsoil has more clay.

Included with this soil in mapping are small areas of Emmert, Mahtomedi, and Meehan soils. Emmert and Mahtomedi soils have more gravel than the Menahga soil. They are in landscape positions similar to those of the Menahga soil. Meehan soils are somewhat poorly drained and are in swales and drainageways. Included soils make up about 2 to 5 percent of the unit.

Permeability is rapid in the Menahga soil. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is low.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is poorly suited to cultivated crops and small grain. Drought and soil blowing are hazards. Planting short-season varieties or irrigating helps to control the droughtiness. Cover crops, windbreaks, conservation tillage systems that leave protective amounts of crop residue on the surface, green manure crops, and stripcropping help to conserve soil moisture, control soil blowing, and increase the content of organic matter.

This soil is fairly well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass.

Overgrazing can result in water erosion and soil blowing. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall. The hazard of erosion is generally slight.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs, and the woodland ordination symbol is 4S.

458C—Menahga loamy sand, 8 to 15 percent slopes. This rolling or hilly, excessively drained soil is on knolls and convex side slopes on outwash plains and valley trains. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is black loamy sand about 2 inches thick. The subsurface layer is very dark grayish brown sand about 3 inches thick. The subsoil is sand about 16 inches thick. In sequence downward it is brown, dark yellowish brown, and yellowish brown. The underlying material to a depth of about 60 inches is yellowish brown coarse sand. In some places the surface layer is thicker. In other places the subsoil has more clay.

Included with this soil in mapping are small areas of Emmert and Mahtomedi soils. Emmert and Mahtomedi soils have more gravel than the Menahga soil. They are in landscape positions similar to those of the Menahga soil. Included soils make up about 1 to 5 percent of the unit.

Permeability is rapid in the Menahga soil. The available water capacity is low. Surface runoff is medium or rapid. The content of organic matter is low or moderately low.

Most areas are used as woodland. Some areas are used for hay, pasture, or cropland.

This soil is poorly suited to cultivated crops and small grain. Drought and soil blowing are hazards. Cover crops, windbreaks, conservation tillage systems that leave protective amounts of crop residue on the surface, green manure crops, and stripcropping help to conserve soil moisture, control soil blowing, and increase the content of organic matter.

This soil is fairly well suited to grasses and legumes for hay or pasture. Drought and soil blowing are hazards. Suitable species include alfalfa, smooth bromegrass, big bluestem, and indiangrass. Overgrazing can cause water erosion and soil blowing. Proper stocking rates, timely deferment of grazing, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IVs, and the woodland ordination symbol is 4S.

458E—Menahga loamy sand, 15 to 25 percent slopes. This hilly or steep, excessively drained soil is on ridges and convex side slopes on outwash plains and valley trains. Individual areas are long and narrow and range from 5 to 100 acres in size.

Typically, the surface layer is very dark gray loamy sand about 3 inches thick. The subsurface layer is very dark grayish brown coarse sand about 3 inches thick. The subsoil is brown sand about 17 inches thick. The underlying material to a depth of about 60 inches is brown sand. In some areas the subsoil has more clay.

Included with this soil in mapping are small areas of Emmert and Mahtomedi soils. Emmert and Mahtomedi soils have more gravel than the Menahga soil. They are in landscape positions similar to those of the Menahga

soil. Included soils make up about 3 to 13 percent of the unit.

Permeability is rapid in the Menahga soil. The available water capacity is low. Surface runoff is rapid. The content of organic matter is low or moderately low.

Most areas are used as woodland. This soil is generally unsuited to cultivated crops, hay, and pasture because of droughtiness and the slope.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. In areas where the protective cover has been disturbed, this soil is easily eroded during periods of heavy rainfall. The hazard of erosion is generally moderate. Operating heavy machinery on the contour rather than up and down the slope minimizes the formation of channels that concentrate runoff and thus helps to control erosion. Equipment should be used with caution on the steep slopes.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. The slope limits the effectiveness of the windbreaks. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Water erosion is a severe hazard unless most of the site is kept vegetated. Site preparation should be limited to an area of no more than 2 feet from where the tree or shrub is to be planted. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIs, and the woodland ordination symbol is 6R.

458F—Menahga loamy sand, 25 to 45 percent slopes. This very steep, excessively drained soil is on ridges, bluffs, and valley walls on outwash plains and moraines. Individual areas are long and narrow and range from 5 to 50 acres in size.

Typically, the surface layer is black loamy sand about 2 inches thick. The subsurface layer is very dark grayish brown sand about 4 inches thick. The subsoil is sand about 18 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The underlying material to a depth of about 60 inches is yellowish brown sand. In some areas the subsoil has more clay.

Included with this soil in mapping are small areas of Emmert and Mahtomedi soils. Emmert and Mahtomedi soils have more gravel than the Menahga soil. They are in landscape positions similar to those of the Menahga soil. Included soils make up about 2 to 7 percent of the unit.

Permeability is rapid in the Menahga soil. The available water capacity is low. Surface runoff is rapid. The content of organic matter is low or moderately low.

Most areas are used as woodland. This soil is generally unsuited to cultivated crops, hay, and pasture because of droughtiness and the slope.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Harvesting that minimizes soil disturbance is necessary. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall. The hazard of erosion is generally moderate or severe. Equipment should be used with caution on the steep slopes.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. The slope limits the effectiveness of the windbreaks. Seedling mortality is moderate because of the droughtiness. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Water erosion is a severe hazard unless most of the site is kept vegetated. Site preparation should be limited to an area of no more than 2 feet from where the tree or shrub is to be planted. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIIs, and the woodland ordination symbol is 6R.

540—Seelyeville muck. This nearly level, very poorly drained soil is in deep depressions and on broad flats on outwash plains, valley trains, and moraines. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 300 acres in size.

Typically, this soil is highly decomposed, black muck about 60 inches thick. In some areas the soil is more acid.

Included with this soil in mapping are small areas of Cathro, Markey, and Rifle soils. Cathro and Markey soils have loamy or sandy underlying material at a depth of less than 51 inches. Rifle soils are less decomposed than the Seelyeville soil. The included

soils are in landscape positions similar to those of the Seelyeville soil. They make up about 1 to 5 percent of the unit.

Permeability is moderately rapid to moderately slow in the Seelyeville soil. The available water capacity is very high. Surface runoff is ponded or very slow. The content of organic matter is very high. The seasonal high water table is 2 feet above to 2 feet below the surface.

Most of the acreage is idle land. This soil is generally unsuited to most uses because of the wetness.

This soil is fairly suited or poorly suited to most tree species. The vegetation in most areas is native reeds, sedges, grasses, willow, alder, and dogwood. A few areas support small stands of black ash, quaking aspen, black spruce, and tamarack. The use of heavy equipment is severely limited because of the wetness. Harvesting in areas of this soft, wet soil is limited to periods when the ground is frozen. Seedling mortality is high because of the extreme wetness. This limitation can be overcome by planting trees that are tolerant of the wetness. Windthrow is a hazard during storms because trees in areas of this soil have a shallow root system. This hazard can be overcome by harvest methods that do not isolate the remaining trees or leave them widely spaced.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the very poor drainage. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIw, and the woodland ordination symbol is 3W.

541—Rifle muck. This nearly level, very poorly drained soil is in deep depressions and on broad flats on outwash plains, lake plains, till plains, and moraines. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the upper layer is black muck about 7 inches thick. The next layer to a depth of about 60 inches is mucky peat. In sequence downward it is black, dark reddish brown, and black. In some areas the soil is mildly alkaline or is more acid.

Included with this soil in mapping are small areas of Cathro and Seelyeville soils. Cathro soils have loamy underlying material at a depth of less than 51 inches. Seelyeville soils are more decomposed than the Rifle soil. Cathro and Seelyeville soils are in landscape positions similar to those of the Rifle soil. They make up about 1 to 5 percent of the unit.

Permeability is moderate or moderately rapid in the Rifle soil. The available water capacity is very high. Surface runoff is very slow or ponded. The content of organic matter is very high. The seasonal high water table is 1 foot above to 1 foot below the surface.

Most of the acreage is idle land. This soil is generally unsuited to most uses because of the wetness.

This soil is fairly suited or poorly suited to most tree species. The vegetation in most areas is native reeds, sedges, grasses, willow, alder, and dogwood. A few areas support small stands of black ash, quaking aspen, black spruce, and tamarack. The use of heavy equipment is severely limited because of the wetness. Harvesting in areas of this soft, wet soil is limited to periods when the ground is frozen. Seedling mortality is high because of the extreme wetness. This limitation can be overcome by planting trees that are tolerant of the wetness. Windthrow is a hazard during storms because trees in areas of this soil have a shallow root system. This hazard can be overcome by harvest methods that do not isolate the remaining trees or leave them widely spaced.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the very poor drainage. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIw, and the woodland ordination symbol is 3W.

543—Markey muck. This nearly level, very poorly drained soil is in deep depressions and on broad flats on outwash plains and moraines. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 200 acres in size.

Typically, the upper layer is black muck about 26 inches thick. The next layer is very dark gray muck about 7 inches thick. The underlying material to a depth of about 60 inches is grayish brown sand. In some areas the soil is more acid.

Included with this soil in mapping are small areas of Isan and Seelyeville soils. Isan soils have an organic surface layer less than 6 inches thick. Seelyeville soils have an organic layer more than 50 inches thick. Isan and Seelyeville soils are in landscape positions similar to those of the Markey soil. They make up about 1 to 5 percent of the unit.

Permeability is moderately slow to moderately rapid in the organic layers of the Markey soil and rapid in the lower part. The available water capacity is very high. Surface runoff is very slow or ponded. The content of organic matter is very high. The seasonal high water table is 1 foot above to 1 foot below the surface.

Most of the acreage is idle land. This soil is generally unsuited to most uses because of the wetness.

This soil is fairly suited or poorly suited to most tree species. The vegetation in most areas is native reeds, sedges, grasses, willow, alder, and dogwood. A few areas support small stands of black ash, quaking aspen, black spruce, and tamarack. The use of heavy equipment is severely limited because of the wetness. Harvesting in areas of this soft, wet soil is limited to periods when the ground is frozen. Seedling mortality is high because of the extreme wetness. This limitation can be overcome by planting trees that are tolerant of the wetness. Windthrow is a hazard during storms because trees in areas of this soil have a shallow root system. This hazard can be overcome by harvest methods that do not isolate the remaining trees or leave them widely spaced.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the very poor drainage. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIw, and the woodland ordination symbol is 2W.

544—Cathro muck. This nearly level, very poorly drained soil is in deep depressions and on broad flats on outwash plains, lake plains, and ground moraines. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the upper layer is black muck about 25 inches thick. The next layer is black fine sandy loam about 3 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled sandy loam. In some areas the organic material is less decomposed. In the southwest corner of the county, the organic layer is mildly alkaline.

Included with this soil in mapping are small areas of Prebish, Rifle, and Seelyeville soils. Prebish soils have 0 to 8 inches of organic material on the surface. Rifle and Seelyeville soils have more than 50 inches of organic material. The included soils are in landscape positions similar to those of the Cathro soil. They make up about 3 to 11 percent of the unit.

Permeability is moderately slow to moderately rapid in the organic layers of the Cathro soil and moderate or moderately slow in the lower part. The available water capacity is very high. Surface runoff is very slow or ponded. The content of organic matter is very high. The seasonal high water table is 1 foot above to 1 foot below the surface.

Most of the acreage is idle land. This soil is generally unsuited to most uses because of the wetness.

This soil is fairly suited or poorly suited to most tree species. The vegetation in most areas is native reeds, sedges, grasses, willow, alder, and dogwood. A few areas support small stands of black ash, quaking aspen, black spruce, and tamarack. The use of heavy equipment is severely limited because of the wetness. Harvesting in areas of this soft, wet soil is limited to periods when the ground is frozen. Seedling mortality is high because of the extreme wetness. This limitation can be overcome by planting trees that are tolerant of the wetness. Windthrow is a hazard during storms because trees in areas of this soil have a shallow root system. This hazard can be overcome by harvest methods that do not isolate the remaining trees or leave them widely spaced.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the very poor drainage. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIw, and the woodland ordination symbol is 2W.

549—Greenwood peat. This nearly level, very poorly drained soil is in deep depressions on moraines, till plains, lake plains, and outwash plains. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the upper layer is dark yellowish brown peat about 6 inches thick. The next layer is very dark brown peat about 6 inches thick. Below this is very dark brown mucky peat about 18 inches thick. The underlying material to a depth of about 60 inches is very dark grayish brown mucky peat. In some areas the soil is less acid.

Included with this soil in mapping are small areas of Cathro and Seelyeville soils. Cathro soils have a loamy substratum within a depth of 50 inches. Seelyeville soils have a higher content of decomposed organic matter than the Greenwood soil. The included soils are in landscape positions similar to those of the Greenwood soil. They make up about 1 to 5 percent of the unit.

Permeability is moderate to very rapid in the Greenwood soil. The available water capacity is very high. Surface runoff is very slow or ponded. The content of organic matter is very high. The seasonal high water table is 1 foot above to 1 foot below the surface.

Most of the acreage is idle land. This soil is generally unsuited to most uses because of the wetness.

This soil is fairly suited or poorly suited to most tree species. The vegetation in most areas is native reeds, sedges, grasses, willow, alder, and dogwood. A few areas support small stands of black ash, quaking aspen, black spruce, and tamarack. The use of heavy equipment is severely limited because of the wetness.

Harvesting in areas of this soft, wet soil is limited to periods when the ground is frozen. Seedling mortality is high because of the extreme wetness. This limitation can be overcome by planting trees that are tolerant of the wetness. Windthrow is a hazard during storms because trees in areas of this soil have a shallow root system. This hazard can be overcome by harvest methods that do not isolate the remaining trees or leave them widely spaced.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of extreme wetness. Seedling mortality is severe because of the very poor drainage. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is Vlw, and the woodland ordination symbol is 4W.

623A—Pierz sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is on plane or slightly convex rises on outwash plains and valley trains. Individual areas are irregular in shape and range from 10 to 500 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is brown sandy loam about 14 inches thick. The underlying material to a depth of about 60 inches is brown very gravelly coarse sand. In some areas the subsoil has less clay.

Included with this soil in mapping are small areas of Chetek, Oesterle, and Warman soils. Chetek soils have a dark surface layer that is thinner than that of the Pierz soil. They are in landscape positions similar to those of the Pierz soil. Oesterle soils are somewhat poorly drained. They are slightly lower on the landscape than the Pierz soil. Warman soils are very poorly drained. They are lower on the landscape than the Pierz soil. Included soils make up about 1 to 5 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Pierz soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is slow. The content of organic matter is moderately low or moderate.

Most areas are used as cropland. Some areas are used for hay, pasture, or woodland.

This soil is well suited to cultivated crops and small grain. Drought is the main hazard. Irrigation can help to overcome the droughtiness. Stripcropping, green manure crops, manure, conservation tillage systems that leave protective amounts of crop residue on the surface, and cover crops help to conserve soil moisture, control soil blowing, and maintain the content of organic matter.

This soil is well suited to grasses and legumes for hay or pasture. Drought is a hazard. Suitable species include alfalfa, crownvetch, smooth bromegrass, big bluestem, little bluestem, indiangrass, and switchgrass. Overgrazing can result in soil blowing. Proper stocking rates, deferment of grazing until the grasses reach a minimum grazing height, applications of fertilizer, weed control, and rotation grazing during the summer help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest.

The trees and shrubs selected for environmental plantings should be those that are tolerant of droughty conditions. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIs, and the woodland ordination symbol is 4A.

623B—Pierz sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on crests and side slopes on outwash plains and valley trains. Individual areas are irregular in shape and range from 10 to 500 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsoil is about 20 inches thick. It is dark brown gravelly loam in the upper part and brown very gravelly sandy loam in the lower part. The underlying material to a depth of about 60 inches is very gravelly sand. It is dark brown in the upper part and yellowish brown in the lower part. In some areas the subsoil has less clay.

Included with this soil in mapping are small areas of Chetek, Mahtomedi, and Oesterle soils. Chetek soils have a thin, dark surface layer and are in landscape positions similar to those of the Pierz soil. Mahtomedi soils are excessively drained and sandy throughout. They are in landscape positions similar to or higher than those of the Pierz soil. Oesterle soils are somewhat poorly drained. They are lower on the landscape than the Pierz soil. Included soils make up about 3 to 14 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Pierz soil and rapid or very rapid in the lower part. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is moderately low or moderate.

Most areas are used as cropland. Some areas are

used for hay, pasture, or woodland.

This soil is well suited to cultivated crops and small grain. Drought is the main hazard. Irrigation can help to overcome the droughtiness. Stripcropping, green manure crops, manure, conservation tillage systems that leave protective amounts of crop residue on the surface, and cover crops help to conserve soil moisture, control soil blowing, slow runoff, control water erosion, maintain or improve tilth, and maintain or increase the content of organic matter.

This soil is well suited to grasses and legumes for hay or pasture. Drought is a hazard. Overgrazing can result in soil blowing. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, and deferment of grazing until the grasses reach a minimum grazing height help to keep the pasture in good condition.

This soil is well suited to red pine, white pine, jack pine, northern red oak, and quaking aspen. Little site preparation is needed in areas of this soil. The control of competing vegetation by mechanical removal or spraying is necessary for the survival and early growth of planted seedlings. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. Where the protective cover has been disturbed, the more sloping areas are easily eroded during periods of heavy rainfall. The hazard of erosion is generally slight in the nearly level areas.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughty conditions. Seedling mortality is moderate because of the droughtiness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIe, and the woodland ordination symbol is 4A.

835—Brainerd-Rock outcrop complex. This map unit occurs as areas of a nearly level to steep, moderately well drained Brainerd soil intermingled with areas of Rock outcrop. The unit is on drumlins and ground moraines. Individual areas are irregular in shape and range from 5 to 25 acres in size. They are about 55 percent Brainerd soil and 30 percent Rock outcrop. The Brainerd soil and the Rock outcrop occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Brainerd soil has a surface layer of black sandy loam about 6 inches thick. The subsurface layer is brown fine sandy loam about 12 inches thick. The subsoil is brown, mottled sandy loam about 28 inches thick. Bedrock is at a depth of about 46 inches. In some areas bedrock is at a depth of more than 60 inches.

Typically, the Rock outcrop consists of granite that is 1 to 10 feet high and 5 to more than 50 feet long. In some areas a thin layer of loamy material or leaf litter overlies the rock surface.

Included in this unit in mapping are small areas of Nokay and Parent soils in swales and drainageways. Nokay soils are somewhat poorly drained. Parent soils are poorly drained. Also included are a few areas of soils that have less than 20 inches of loamy material over bedrock. Included soils make up about 1 to 15 percent of the map unit.

Permeability is moderate or moderately rapid in the upper part of the Brainerd soil and slow or very slow in the lower part. Surface runoff is slow to rapid. The content of organic matter is low to moderate. The water table is at a depth of 1.5 to 2.5 feet.

Most areas are forested or are used for pasture. Inactive quarries are in some areas (fig. 6).

Northern red oak, aspen, birch, and pine are common tree species. Trees grow fairly well on the Brainerd soil. Planting trees by machine is impractical in these areas.

In areas of the Brainerd soil, the land capability classification is IIe and the woodland ordination symbol is 4D. No land capability classification or woodland ordination symbol is assigned to the Rock outcrop.

928B—Cushing-Mahtomedi-DeMontreville complex, 2 to 8 percent slopes. These gently undulating or rolling soils are on knolls and side slopes on moraines. The Cushing and DeMontreville soils are well drained, and the Mahtomedi soil is excessively drained. Individual areas are irregular in shape and range from 5 to 300 acres in size. They are about 40 percent Cushing soil, 25 percent Mahtomedi soil, and 20 percent DeMontreville soil. These soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Cushing soil has a surface layer of black fine sandy loam about 6 inches thick. The subsurface layer is brown fine sandy loam about 6 inches thick. The subsoil is about 29 inches thick. In sequence downward it is brown sandy loam, brown sandy clay loam, and brown sandy loam. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the subsoil has less clay. In other areas the soil is moderately well drained.

Typically, the Mahtomedi soil has a surface layer of very dark grayish brown loamy sand about 5 inches thick. The subsurface layer is brown loamy sand about 7 inches thick. The subsoil is about 26 inches thick. It is

Figure 6.—An abandoned quarry in an area of the Brainerd-Rock outcrop complex.

dark yellowish brown gravelly coarse sand in the upper part and brown gravelly sand in the lower part. The underlying material to a depth of about 60 inches is brown gravelly sand. In some areas the soil has a higher content of fine sand and a lower content of gravel.

Typically, the DeMontreville soil has a surface layer of very dark brown loamy fine sand about 6 inches thick. The subsurface layer is brown loamy sand about 11 inches thick. The subsoil is about 17 inches thick. It is brown loamy sand in the upper part and brown sandy clay loam in the lower part. The underlying material to a depth of about 60 inches is brown coarse sandy loam. In some areas the sandy surface soil is less than 20 inches thick. In other areas the soil is moderately well drained.

Included with these soils in mapping are small areas of Alstad, Emmert, Parent, Prebish, and Rifle soils. Alstad soils are somewhat poorly drained and are on side slopes and in swales. Emmert soils are excessively drained and are in landscape positions similar to those of the Cushing, Mahtomedi, and DeMontreville soils. They have more gravel than those soils. Parent and Prebish soils are poorly drained and very poorly drained. They are in shallow depressions. Rifle soils are very poorly drained and organic. They are in depressions. Included soils make up about 1 to 15 percent of the unit.

Permeability is moderate in the upper part of the Cushing soil and moderately slow in the lower part. It is rapid in the Mahtomedi soil. It is rapid in the upper part of the DeMontreville soil and moderately slow in the lower part. The available water capacity is moderate in the Cushing soil and low in the Mahtomedi and DeMontreville soils. Surface runoff is slow or medium on all three soils. The content of organic matter is moderately low or moderate in the Cushing soil and low or moderately low in the Mahtomedi and DeMontreville soils.

Most areas of these soils are used as woodland. Some areas are used for hay, pasture, or cropland.

These soils are poorly suited to the cultivated crops commonly grown in the county. Erosion is a hazard in areas of the Cushing soil, and drought is a hazard in areas of the DeMontreville and Mahtomedi soils. Terraces and crop residue management help to control erosion and increase the amount of water available for plant growth.

These soils are fairly well suited to pasture and hay. Erosion is a hazard in areas of the Cushing soil, and drought is a hazard in areas of the DeMontreville and Mahtomedi soils. Proper stocking rates, pasture rotation, and deferment of grazing during dry periods help to keep the pasture in good condition. Planting short-season varieties helps to overcome the droughtiness.

These soils are well suited to northern red oak and quaking aspen. Pine and spruce grow best on the more sandy Mahtomedi and DeMontreville soils. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Where the protective cover has been disturbed, the more sandy and sloping areas are easily eroded during periods of heavy rainfall. Droughtiness can cause seedling mortality in areas of the Mahtomedi and DeMontreville soils. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest in areas of the more sandy soils. Operating heavy machinery on the contour rather than up and down the slope minimizes the formation of channels that concentrate runoff and thus helps to control erosion.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings in areas of the Cushing soil. The trees and shrubs selected for windbreaks and environmental plantings in areas of the Mahtomedi and DeMontreville soils should be those that are tolerant of droughty conditions. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Seedling mortality is moderate because of the droughtiness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIe in areas of the Cushing soil, IVs in areas of the Mahtomedi soil, and IIIs in areas of the DeMontreville soil. The woodland ordination symbol is 4L in areas of the Cushing soil, 2S in areas of the Mahtomedi soil, and 4S in areas of the DeMontreville soil.

928C—Cushing-Mahtomedi-DeMontreville complex, 8 to 15 percent slopes. These rolling or hilly soils are on knolls and convex side slopes on moraines. The Cushing and DeMontreville soils are well drained, and the Mahtomedi soil is excessively drained. Individual areas are irregular in shape and range from 5 to 300 acres in size. They are about 40 percent Cushing soil, 25 percent Mahtomedi soil, and 20 percent DeMontreville soil. These soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Cushing soil has a surface layer of black fine sandy loam about 5 inches thick. The subsurface layer is about 14 inches thick. It is brown fine sandy loam in the upper part and brown sandy loam in the lower part. The next 10 inches is brown sandy clay loam that has tongues of brown sandy loam. The subsoil is brown sandy clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the subsoil has less clay.

Typically, the Mahtomedi soil has a surface layer of black loamy sand about 5 inches thick. The subsurface layer is brown coarse sand about 5 inches thick. The subsoil is yellowish brown gravelly coarse sand about 28 inches thick. The underlying material to a depth of about 60 inches is brown gravelly coarse sand. In some areas the soil has a higher content of fine sand and a lower content of gravel.

Typically, the DeMontreville soil has a surface layer of very dark brown loamy fine sand about 6 inches thick. The subsurface layer is brown loamy sand about 21 inches thick. The subsoil is about 19 inches thick. It is brown loamy sand in the upper part and brown sandy clay loam in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the sandy surface soil is less than 20 inches thick.

Included with these soils in mapping are small areas of Alstad, Emmert, Prebish, and Rifle soils. Alstad soils are somewhat poorly drained and are in swales. Emmert soils are excessively drained. They are in landscape positions similar to those of the Cushing, Mahtomedi, and DeMontreville soils. They have more gravel than those soils. Prebish soils are very poorly

drained and are in shallow depressions. Rifle soils are very poorly drained and organic. They are in depressions. Included soils make up about 1 to 15 percent of the unit.

Permeability is moderate in the upper part of the Cushing soil and moderately slow in the lower part. It is rapid in the Mahtomedi soil. It is rapid in the upper part of the DeMontreville soil and moderately slow in the lower part. The available water capacity is moderate in the Cushing soil and low in the Mahtomedi and DeMontreville soils. Surface runoff is medium or rapid on all three soils. The content of organic matter is moderately low or moderate in the Cushing soil and low or moderately low in the Mahtomedi and DeMontreville soils.

Most areas of these soils are used as woodland. Some areas are used for hay, pasture, or cropland.

These soils are poorly suited to the cultivated crops commonly grown in the county. Erosion is a hazard in areas of the Cushing and DeMontreville soils, and drought is a hazard in areas of the Mahtomedi soil. Terraces and crop residue management help to control erosion and increase the amount of water available for plant growth.

These soils are well suited or fairly well suited to pasture and hay. Erosion is a hazard in areas of the DeMontreville and Cushing soils, and drought is a hazard in areas of the Mahtomedi soil. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition. Planting short-season varieties helps to overcome the droughtiness.

These soils are well suited to northern red oak and quaking aspen. Pine and spruce grow best on the Mahtomedi and DeMontreville soils. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Where the protective cover has been disturbed, the more sandy and sloping areas are easily eroded during periods of heavy rainfall. Droughtiness can cause seedling mortality in areas of the Mahtomedi and DeMontreville soils. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of moisture is highest in areas of the more sandy soils. Operating heavy machinery on the contour rather than up and down the slope minimizes the formation of channels that concentrate runoff and thus helps to control erosion.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings in areas of the Cushing soil. The trees and shrubs selected for windbreaks and environmental plantings in areas of the Mahtomedi and DeMontreville soils should be those that are tolerant of droughty conditions. Leaving some vegetation on the surface during the early years of seedling establishment helps to control soil blowing. Seedling mortality is moderate because of the droughtiness. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is IIIe in areas of the Cushing soil, IVs in areas of the Mahtomedi soil, and IVe in areas of the DeMontreville soil. The woodland ordination symbol is 4L in areas of the Cushing soil, 2S in areas of the Mahtomedi soil, and 4S in areas of the DeMontreville soil.

928E—Cushing-Mahtomedi-DeMontreville complex, 15 to 25 percent slopes. These hilly or steep soils are on ridges and convex side slopes on moraines. The Cushing and DeMontreville soils are well drained, and the Mahtomedi soil is excessively drained. Individual areas are irregular in shape and range from 5 to 200 acres in size. They are about 40 percent Cushing soil, 25 percent Mahtomedi soil, and 20 percent DeMontreville soil. These soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Cushing soil has a surface layer of very dark gray fine sandy loam about 3 inches thick. The subsurface layer is brown fine sandy loam about 5 inches thick. The subsoil is about 26 inches thick. It is brown fine sandy loam in the upper part and brown loam in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the subsoil has less clay.

Typically, the Mahtomedi soil has a surface layer of black loamy sand about 4 inches thick. The subsurface layer is brown coarse sand about 8 inches thick. The subsoil is brown gravelly coarse sand about 24 inches thick. The underlying material to a depth of about 60 inches is brown gravelly coarse sand. In some areas the soil has a higher content of fine sand and a lower content of gravel.

Typically, the DeMontreville soil has a surface layer of very dark grayish brown loamy fine sand about 5 inches thick. The subsurface layer is about 31 inches thick. It is dark yellowish brown loamy sand in the upper part and brown sand in the lower part. The subsoil is about 14 inches thick. It is brown sandy loam in the upper part and brown fine sandy loam in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the sandy surface soil is less than 20 inches thick.

Included with these soils in mapping are small areas of Emmert, Prebish, and Rifle soils. Emmert soils are excessively drained and are in landscape positions similar to those of the Cushing, Mahtomedi, and

DeMontreville soils. They have more gravel than those soils. Prebish soils are very poorly drained and are in shallow depressions. Rifle soils are very poorly drained and organic. They are in depressions. Included soils make up about 1 to 15 percent of the unit.

Permeability is moderate in the upper part of the Cushing soil and moderately slow in the lower part. It is rapid in the Mahtomedi soil. It is rapid in the upper part of the DeMontreville soil and moderately slow in the lower part. The available water capacity is moderate in the Cushing soil and low in the Mahtomedi and DeMontreville soils. Surface runoff is rapid on all three soils. The content of organic matter is moderately low or moderate in the Cushing soil and low or moderately low in the Mahtomedi and DeMontreville soils.

Most areas of these soils are used as woodland. These soils are generally unsuited to cultivated crops and pasture because of the slope.

These soils are well suited to northern red oak and quaking aspen. Pine and spruce grow best on the Mahtomedi and DeMontreville soils. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Where the protective cover has been disturbed, the more sandy and sloping areas are easily eroded during periods of heavy rainfall. Droughtiness can cause seedling mortality in areas of the Mahtomedi and DeMontreville soils. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest in areas of the more sandy soils. Operating heavy machinery on the contour rather than up and down the slope minimizes the formation of channels that concentrate runoff and thus helps to control erosion.

The land capability classification is VIe in areas of the Cushing and DeMontreville soils and VIs in areas of the Mahtomedi soil. The woodland ordination symbol is 4R in areas of the Cushing and DeMontreville soils and 2R in areas of the Mahtomedi soil.

928F—Cushing-Mahtomedi-DeMontreville complex, 25 to 45 percent slopes. These very steep soils are on ridges and bluffs on moraines. The Cushing and DeMontreville soils are well drained, and the Mahtomedi soil is excessively drained. The Cushing soil is in the less sloping areas. Individual areas are irregular in shape and range from 5 to 100 acres in size. They are about 40 percent Cushing soil, 25 percent Mahtomedi soil, and 20 percent DeMontreville soil. These soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Cushing soil has a surface layer of very dark gray fine sandy loam about 4 inches thick. The subsurface layer is brown sandy loam about 6 inches thick. The subsoil is about 25 inches thick. It is brown sandy loam in the upper part and brown loam in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the subsoil has less clay.

Typically, the Mahtomedi soil has a surface layer of very dark gray loamy sand about 3 inches thick. The subsurface layer is brown loamy sand about 10 inches thick. The subsoil is brown gravelly coarse sand about 12 inches thick. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In some areas the soil has a higher content of fine sand and a lower content of gravel.

Typically, the DeMontreville soil has a surface layer of very dark gray loamy fine sand about 3 inches thick. The subsurface layer is brown loamy sand about 11 inches thick. The subsoil is about 25 inches thick. It is yellowish brown sand in the upper part and brown sandy loam in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the sandy surface soil is less than 20 inches thick.

Included with these soils in mapping are small areas of Emmert, Prebish, and Rifle soils. Emmert soils are excessively drained and are in landscape positions similar to those of the Cushing, Mahtomedi, and DeMontreville soils. They have more gravel than those soils. Prebish soils are very poorly drained and are in shallow depressions. Rifle soils are very poorly drained and organic. They are in depressions. Included soils make up about 1 to 15 percent of the unit.

Permeability is moderate in the upper part of the Cushing soil and moderately slow in the lower part. It is rapid in the Mahtomedi soil. It is rapid in the upper part of the DeMontreville soil and moderately slow in the lower part. The available water capacity is moderate in the Cushing soil and low in the Mahtomedi and DeMontreville soils. Surface runoff is rapid on all three soils. The content of organic matter is moderately low or moderate in the Cushing soil and low or moderately low in the Mahtomedi and DeMontreville soils.

Most areas of these soils are used as woodland. These soils are unsuited to cultivated crops and pasture because of the slope.

These soils are well suited to northern red oak and quaking aspen. Pine and spruce grow best on the more sandy Mahtomedi and DeMontreville soils. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. In areas where the protective cover has been disturbed, these soils are easily eroded during periods of heavy rainfall. Droughtiness can cause seedling mortality in areas of the Mahtomedi and DeMontreville

soils. Equipment should be used with caution on the steep slopes.

The land capability classification is VIe in areas of the Cushing soil, VIIs in areas of the Mahtomedi soil, and VIIe in areas of the DeMontreville soil. The woodland ordination symbol is 4R in areas of the Cushing and DeMontreville soils and 2R in areas of the Mahtomedi soil.

1015—Psamments, nearly level. This map unit consists of nearly level to sloping, excessively drained soils in areas of sandy outwash. These areas have been mixed and reshaped by extensive earth moving or grading. Individual areas range from less than 3 to more than 50 acres in size.

The surface layer is mainly sandy material that has been redistributed or mixed to varying depths. In most places the underlying material is a mixture of topsoil, subsoil, and underlying material from the sandy or gravelly outwash. The soils are fine sand, sand, coarse sand, loamy sand, loamy fine sand, or loamy coarse sand. In some areas the seasonal high water table is at the surface or within a depth of 60 inches. In other areas where the surface is not protected by a vegetative cover, erosion is active.

Included with these soils in mapping are small areas of borrow pits, where loamy or sandy material has been removed.

Most of the acreage is associated with urban areas, highways, railroads, and recreational areas. Some unreclaimed areas have steep slopes. Those on the lower parts of the landscape are subject to ponding. In most reclaimed areas, the land has been reshaped, the topsoil has been replaced, and vegetation has been established.

Onsite investigation is necessary to determine the limitations affecting most proposed uses. Because of the mixing and the variability of the soil material, no soil interpretations have been made for this unit.

No land capability classification or woodland ordination symbol is assigned to this unit.

1016—Udorthents, loamy. This map unit consists of nearly level to very steep, well drained to somewhat poorly drained soils in areas of glacial till. These areas have been mixed and reshaped by extensive earth moving or grading. Individual areas range from less than 3 to more than 50 acres in size.

The surface layer is mainly loamy material that has been redistributed or mixed to varying depths. In most places the underlying material is a mixture of topsoil, subsoil, and underlying material derived from glacial till. The soils dominantly are sandy loam, fine sandy loam, sandy clay loam, or loam. Pockets or lenses of sand or gravel, however, commonly occur in the loamy glacial till. In some areas the seasonal high water table is at or near the surface. In other areas where the surface is not protected by a vegetative cover, erosion is active.

Included with these soils in mapping are small areas of borrow pits, where loamy or sandy material has been removed.

Most of the acreage is associated with urban areas, highways, railroads, and recreational areas. Some unreclaimed areas have steep slopes. Those on the lower parts of the landscape are subject to ponding. In most reclaimed areas, the land has been reshaped, the topsoil has been replaced, and vegetation has been established.

Onsite investigation is necessary to determine the limitations affecting most proposed uses. Because of the mixing and the variability of the soil material, no soil interpretations have been made for this unit.

No land capability classification or woodland ordination symbol is assigned to this unit.

1030—Pits, gravel-Udorthents complex. This map unit consists of areas of open excavations from which gravel is being or has been removed and areas of filled land. The gravel deposits are in fairly evenly scattered areas throughout the county. The size, shape, and depth of the gravel pits depend on the quality and quantity of gravel. The pits range from 3 to 40 acres in size. The areas of Udorthents occur in all excavations but are most common in the older, inactive pits or reclaimed pits. Pits smaller than 3 acres are identified on the soil maps by a special symbol.

The gravel pits are on various landforms. The more extensive pits are on glacial eskers and outwash terraces. Some of the smaller pits are in areas of glacial till that have pockets of sand and gravel. The Darling Esker is an example of an extensive pit on an esker. Most of the extensive pits are in areas adjacent to Emmert, Pierz, Chetek, or Mahtomedi soils. The surface layer and existing vegetation have been stripped away and the sand and gravel removed.

The texture of the surface layer and underlying material varies in pits that are in areas of loamy outwash or till. If the pit is in an area of outwash, the soil material is sandy or gravelly. In reclaimed pits the steeper pit walls have been shaped to gentler slopes.

Some of the abandoned pits have been or are being reclaimed by reshaping and reseeding. The topsoil was replaced in some pits before the area was reseeded. Trees, shrubs, and grasses grow in most of the abandoned pits. Water is ponded in many of the gravel pits, especially in the deeper ones.

No land capability classification or woodland ordination symbol is assigned to this unit.

1934—Bowstring muck. This nearly level, very poorly drained soil is on broad flats and in shallow depressions on flood plains, lake plains, and outwash plains. It is subject to flooding and ponding. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is black muck about 4 inches thick. The next layer is grayish brown sand about 4 inches thick. Below this is black muck about 33 inches thick. The underlying material to a depth of about 60 inches is grayish brown sand. In some areas the underlying material is at a depth of more than 60 inches.

Included with this soil in mapping are small areas of Becker, Fordum, and Winterfield soils. Becker soils are well drained. Winterfield soils are somewhat poorly drained. Becker and Winterfield soils are in the higher convex positions on the flood plains. Fordum soils are sandy and are in the slightly higher positions on the flood plains. Included soils make up about 1 to 14 percent of the unit.

Permeability is moderately rapid to moderately slow in the Bowstring soil. The available water capacity is very high. Surface runoff is very slow. The content of organic matter is very high. The seasonal high water table is within a depth of 2 feet.

Most of the acreage is idle land. This soil is generally unsuited to most uses because of the frequent flooding.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is severe because of the very poor drainage. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIw. No woodland ordination symbol is assigned.

1946—Fordum-Winterfield complex. These nearly level soils are on flats and in swales on flood plains. The Fordum soil is poorly drained or very poorly drained, and the Winterfield soil is somewhat poorly drained. Individual areas are irregular in shape or are long and narrow and range from 5 to more than 100 acres in size. They are about 60 percent Fordum soil and 30 percent Winterfield soil. The Fordum and Winterfield soils are subject to frequent flooding, and the Fordum soil is subject to ponding. These soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Fordum soil has a surface layer of black silt loam about 8 inches thick. The upper part of the underlying material is very dark gray, mottled, stratified silt loam and fine sand. The lower part to a depth of about 60 inches is grayish brown, mottled sand.

Typically, the Winterfield soil has a surface layer of black loamy sand about 4 inches thick. The upper part of the underlying material is very dark brown, stratified loamy sand and loamy fine sand. The lower part to a depth of about 60 inches is dark grayish brown, mottled sand. In some areas the soil is gravelly below a depth of 40 inches. In other areas flooding is less frequent.

Included with these soils in mapping are small areas of Becker and Bowstring soils. Becker soils are well drained and are in the higher, more convex areas on the flood plains. Bowstring soils are in positions on the flood plains similar to or lower than those of the Fordum and Winterfield soils. They have an organic surface layer. Included soils make up about 1 to 10 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Fordum soil and rapid or very rapid in the lower part. It is rapid in the Winterfield soil. The available water capacity is high in the Fordum soil and low in the Winterfield soil. Surface runoff is very slow or ponded on the Fordum soil and slow on the Winterfield soil. The content of organic matter is high or very high in the Fordum soil and moderately low or moderate in the Winterfield soil. In areas of the Fordum soil, the seasonal high water table is 1 foot above to 1 foot below the surface. In areas of the Winterfield soil, it is at a depth of 0.5 foot to 1.5 feet.

Most of the acreage of these soils is idle land. These soils are generally unsuited to most uses because of the frequent flooding.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is severe because of the very poor drainage. Cultivation or applications of herbicide help to remove competing vegetation. Growth rates of trees are slow in areas of these soils; however, a drainage system can improve these rates. The wetness is a limitation affecting the harvesting and planting of trees. Clearcutting helps to maintain the potential for seedling regeneration and helps to overcome the hazard of windthrow.

The land capability classification is VIw. The woodland ordination symbol is 2W in areas of the Fordum soil and 5W in areas of the Winterfield soil.

1973—Meehan-Isan complex. These nearly level, somewhat poorly drained to very poorly drained soils are on broad flats, in swales, and in drainageways on outwash plains. The Isan soil is subject to ponding. Individual areas are irregular in shape and range from 5 to more than 200 acres in size. They are about 60 percent Meehan soil and 30 percent Isan soil. These

soils occur as areas so intricately mixed or so small in size that separating them in mapping is not practical.

Typically, the Meehan soil has a surface layer of very dark grayish brown loamy sand about 7 inches thick. The subsurface layer is dark grayish brown, mottled sand about 6 inches thick. The subsoil is brown, mottled sand about 15 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled coarse sand. In some areas the underlying material has more gravel. In other areas the surface layer is thicker. In places the soil has more fine sand.

Typically, the Isan soil has a surface layer of black sandy loam about 8 inches thick. The subsurface layer is very dark gray, mottled loamy sand about 5 inches thick. The subsoil is dark grayish brown, mottled sand about 12 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled coarse sand. In some areas the soil has more fine sand.

Included with these soils in mapping are small areas of Hubbard, Markey, and Menahga soils. Hubbard and Menahga soils are excessively drained and are in the more convex areas. Markey soils have an organic layer 16 to 50 inches thick and are in landscape positions similar to those of the Meehan and Isan soils. Included soils make up about 1 to 10 percent of the unit.

Permeability is rapid in both soils. The available water capacity is low. Surface runoff is slow on the Meehan soil and slow to ponded on the Isan soil. The content of organic matter is low to moderate in the Meehan soil and moderate to very high in the Isan soil. In areas of the Meehan soil, the seasonal high water table is at a depth of 1 to 3 feet. In areas of the Isan soil, it is at a depth of 0.5 foot to 2.0 feet.

Most areas of these soils are used as cropland. Some areas are used for hay, pasture, or woodland.

These soils are generally unsuited to cultivated crops and small grain. Wetness is a limitation. Soil blowing is a hazard. Open ditches, subsurface drains, surface drains, or a combination of these methods help to remove excess water. Some low areas of these soils or some areas that lack suitable outlets for drainage systems may be difficult to drain. Windbreaks and conservation tillage systems that leave protective amounts of crop residue on the surface help to control soil blowing.

These soils are poorly suited to grasses and legumes for hay or pasture. Wetness is a major limitation. The grasses and legumes selected for hay or pasture should be those that are tolerant of wetness. These plants include birdsfoot trefoil, red clover, reed canarygrass, and creeping foxtail. Overgrazing when the soil is wet causes compaction. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The Meehan soil is well suited to trees that are tolerant of moderate wetness. Red pine, white pine, white spruce, quaking aspen, and northern red oak are the most common species. Adequate site preparation and control of competing vegetation are necessary before suitable conifers can be established. Droughtiness can cause seedling mortality. It can be overcome by selecting good-quality planting stock and by planting early in the spring, when the amount of soil moisture is highest. The use of equipment is restricted during wet periods because the soils are soft and cannot support heavy equipment. Harvesting activities on these soft, wet soils are limited to periods when the ground is frozen. Trees on these soils have a shallow root system and may be blown over during storms. Harvest methods that do not isolate the remaining trees or leave them widely spaced reduce the hazard of windthrow.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness, particularly in areas of the Isan soil. Seedling mortality is moderate because of the wetness. The wetness can delay planting in the spring.

The land capability classification is IVw in areas of the Meehan soil and Vw in areas of the Isan soil. The woodland ordination symbol is 6W in areas of the Meehan soil. No woodland ordination symbol is assigned to the Isan soil.

1976B—Brainerd sandy loam, 1 to 4 percent slopes, extremely stony. This nearly level or gently sloping, moderately well drained soil is on crests and side slopes on drumlins and ground moraines. Stones 10 inches or more in diameter cover 3 to 15 percent of the surface. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 6 inches thick. The subsurface layer is brown, mottled sandy loam about 5 inches thick. The subsoil is also brown, mottled sandy loam. It is about 30 inches thick. The underlying material to a depth of about 60 inches is brown, mottled sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the subsoil has more clay. In other areas the surface soil has more sand. In some places the surface soil is thinner and has a lower content of organic matter because of erosion. In other places it is less stony.

Included with this soil in mapping are small areas of Flak, Nokay, and Parent soils. Flak soils are well drained and are higher on the landscape than the Brainerd soil. Nokay soils are somewhat poorly drained

and are slightly lower on the landscape than the Brainerd soil. Parent soils are poorly drained and are lower on the landscape than the Brainerd soil. Included soils make up about 1 to 14 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Brainerd soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is low to moderate. A perched water table is at a depth of 1.5 to 2.5 feet.

Most areas are used for pasture. Some areas are wooded or are idle land. This soil is generally unsuited to cultivated crops, hay, and pasture because of the stones on the surface. Heavy machinery is needed to remove some stones. Other stones can be removed by hand or with a stone picker.

If the surface stones are removed, this soil is well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and water erosion are needed. Conservation tillage systems that leave protective amounts of crop residue on the surface, cover crops, crop rotations that include grasses and legumes, terraces and diversions, grassed waterways, and grade stabilization structures help to control water erosion.

If the surface stones are removed, this soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling water erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is fairly suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Most stands are mixed northern red oak and quaking aspen. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Seedlings need to be planted by hand. It may be necessary to remove some large stones during harvesting operations. This soil is wet in the spring and after heavy rainfall because of the perched water table. The wetness limits the ability of the soil to support heavy machinery. Operating machinery only during dry periods minimizes compaction and increases the seedling survival rate. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation. Planting by hand may be necessary unless the surface stones are removed.

The land capability classification is VIs, and the woodland ordination symbol is 4X.

1977B—Mora fine sandy loam, 1 to 4 percent slopes, extremely stony. This nearly level or gently sloping, moderately well drained soil is on crests and side slopes on moraines and drumlins. Stones 10 inches or more in diameter cover 3 to 15 percent of the surface. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black fine sandy loam about 4 inches thick. The subsurface layer is brown sandy loam about 11 inches thick. The subsoil is mottled sandy loam about 34 inches thick. It is brown in the upper part and reddish brown in the lower part. The underlying material to a depth of about 60 inches is dark reddish brown, mottled sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the subsoil and underlying material have more clay. In other areas the surface soil is thinner and has a lower content of organic matter because of erosion. In places it is less stony.

Included with this soil in mapping are small areas of Milaca, Parent, and Ronneby soils. Milaca soils are well drained and are on the more convex rises. Parent soils are poorly drained and are in concave areas and drainageways. Ronneby soils are somewhat poorly drained and are in slight swales and on side slopes. Included soils make up about 2 to 14 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Mora soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is slow or medium. The content of organic matter is moderate. A perched water table is at a depth of 2 to 3 feet.

Most areas are used for pasture. Some areas are wooded or are idle land. This soil is generally unsuited to cultivated crops, hay, and pasture because of the stones on the surface. Heavy machinery is needed to remove some stones. Other stones can be removed by hand or with a stone picker.

If the surface stones are removed, this soil is well suited to cultivated crops and small grain. Water erosion is the main hazard. Conservation practices that help to control surface runoff and water erosion are needed. Conservation tillage systems that leave protective amounts of crop residue on the surface, cover crops, crop rotations that include grasses and legumes, terraces and diversions, grassed waterways,

and grade stabilization structures help to control erosion.

If the surface stones are removed, this soil is well suited to alfalfa, smooth bromegrass, and orchardgrass for hay or pasture. A cover of grasses and legumes is effective in controlling water erosion. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, applications of fertilizer, weed control, pasture rotation, deferment of grazing until the grasses reach a minimum grazing height, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is only fairly suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Most stands are mixed northern red oak and quaking aspen. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. Seedlings need to be planted by hand. It may be necessary to remove some large stones during harvesting operations. This soil is wet in the spring and after heavy rainfall because of the perched water table. The wetness limits the ability of the soil to support heavy machinery. Operating machinery only during dry periods minimizes compaction and increases the seedling survival rate. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation. Planting by hand may be necessary unless surface stones are removed.

The land capability classification is VIs, and the woodland ordination symbol is 5X.

1978—Nokay loam, extremely stony. This nearly level, somewhat poorly drained soil is on side slopes, on broad flats, and in swales on drumlins and ground moraines. Stones 10 inches or more in diameter cover 3 to 15 percent of the surface (fig. 7). Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark brown loam about 5 inches thick. The subsurface layer is brown, mottled sandy loam about 12 inches thick. The subsoil also is brown, mottled sandy loam. It is about 23 inches thick. The underlying material to a depth of about 60 inches is brown, mottled sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the surface soil is coarser. In other areas it is less stony.

Included with this soil in mapping are small areas of Brainerd, Parent, and Prebish soils. Brainerd soils are moderately well drained and are on convex rises. Parent soils are poorly drained and are in swales and drainageways. Prebish soils are very poorly drained and are in shallow depressions. Included soils make up about 2 to 10 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Nokay soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is slow. The content of organic matter is moderate or high. A perched water table is at a depth of 1 to 3 feet.

Most areas are used for pasture. Some areas are wooded or are idle land.

This soil is generally unsuited to cultivated crops, hay, and pasture because of the stoniness and the wetness.

If this soil is drained and the surface stones are removed, it is well suited to cultivated crops and small grain. The stoniness and wetness are the main limitations. Open ditches, subsurface drains, or surface drains help to remove excess water. Heavy machinery is needed to remove some stones. Other stones can be removed by hand or with a stone picker. Conservation tillage systems that leave protective amounts of crop residue on the surface help to maintain or increase the content of organic matter and improve tilth.

If this soil is drained and the surface stones are removed, it is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important species are paper birch, ash, and American elm. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. This soil is wet in the spring and after heavy rainfall because of the perched water table. The wetness limits the ability of the soil to support heavy machinery. Operating machinery only during dry periods minimizes compaction and increases the seedling survival rate. The firm subsoil restricts the rooting depth of some plants.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation. In areas where surface stones are not removed, seedlings may need to be planted by hand.

Figure 7.—A pastured area of Nokay loam, extremely stony. Numerous stones limit the use of this somewhat poorly drained soil.

The land capability classification is VIs, and the woodland ordination symbol is 4X.

1979—Parent loam, extremely stony. This nearly level, poorly drained soil is on broad flats, in swales, and in drainageways on moraines. Stones 10 inches or more in diameter cover 3 to 15 percent of the surface. Individual areas are irregular in shape and range from 10 to 50 acres in size.

Typically, the surface layer is black loam about 6 inches thick. The subsurface layer is very dark gray, mottled loam about 7 inches thick. The subsoil is about 29 inches thick. In sequence downward it is grayish brown, mottled loam; brown, mottled loam; and dark brown, mottled sandy loam. The underlying material to a depth of about 60 inches is brown sandy loam. In some areas the surface soil and subsoil are coarser. In other areas the surface soil is less stony.

Included with this soil in mapping are small areas of Nokay and Prebish soils. Nokay soils are somewhat poorly drained and are on the more convex rises. Prebish soils are very poorly drained and are in shallow depressions. Included soils make up about 3 to 8 percent of the unit.

Permeability is moderate in the upper part of the Parent soil and slow or very slow in the lower part. The available water capacity is moderate. Surface runoff is slow. The content of organic matter is high or very high. The water table is at a depth of 0.5 foot to 2.5 feet.

Most areas are used as pasture or hay. Some areas are wooded.

This soil is generally unsuited to cultivated crops and small grain. The stones on the surface and the wetness are the main limitations. Heavy machinery is needed to

remove some stones. Other stones can be removed by hand or with a stone picker. Open ditches, subsurface drains, or surface drains help to remove excess water. Some low areas of this soil or some areas that lack suitable outlets for drainage systems may be difficult to drain.

If the surface stones are removed, this soil is well suited to birdsfoot trefoil, red clover, reed canarygrass, or creeping foxtail for hay or pasture. The grasses and legumes selected for hay or pasture should be those that are tolerant of wetness. If this soil is used for pasture, the major concerns are overgrazing and grazing when the soil is wet. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is moderate because of the poor drainage. In the spring, seedlings should be planted by hand because of the stoniness and wetness.

The land capability classification is VIs. No woodland ordination symbol is assigned.

1980—Ronneby loam, extremely stony. This nearly level, somewhat poorly drained soil is on side slopes, on broad flats, and in swales on ground moraines and drumlins. Stones 10 inches or more in diameter cover 3 to 15 percent of the surface. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black loam about 4 inches thick. The subsurface layer is dark grayish brown, mottled fine sandy loam about 7 inches thick. The subsoil is about 27 inches thick. In sequence downward it is brown, mottled fine sandy loam and dark reddish gray and reddish brown, mottled sandy loam. The underlying material to a depth of about 60 inches is reddish brown sandy loam. The lower part of the subsoil and the underlying material are firm. In some areas the surface soil is less stony.

Included with this soil in mapping are small areas of Mora and Parent soils. Mora soils are moderately well drained and are in the more convex areas. Parent soils are poorly drained and are in swales. Included soils make up about 4 to 12 percent of the unit.

Permeability is moderate or moderately rapid in the upper part of the Ronneby soil and slow or very slow in the lower part. The available water capacity is low. Surface runoff is slow. The content of organic matter is moderately low or low. A perched water table is at a depth of 1.5 to 3.0 feet.

Most areas are used as woodland. Some areas are used for pasture or are idle land.

This soil is generally unsuited to cultivated crops, hay, and pasture because of the stoniness and wetness.

If this soil is drained and the stones on the surface are removed, this soil is fairly well suited to cultivated crops and small grain. The stoniness and wetness are the main limitations. Open ditches, subsurface drains, or surface drains help to remove excess water. Heavy machinery is needed to remove some surface stones. Other stones can be removed by hand or with a stone picker. Conservation tillage systems which leave protective amounts of crop residue on the surface and winter cover crops help to maintain or increase the content of organic matter and improve tilth.

If the surface stones are removed, this soil is well suited to alfalfa, birdsfoot trefoil, smooth bromegrass, and orchardgrass for hay or pasture. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, applications of fertilizer, weed control, and restricted grazing during wet periods help to keep the pasture in good condition.

This soil is well suited to many upland tree species. Northern red oak and quaking aspen are the most common species. Other important tree species are paper birch, ash, and American elm. Adequate site preparation and control of competing vegetation are necessary for the survival and early growth of planted seedlings. This soil is wet in the spring and after heavy rainfall because of the perched water table. The wetness limits the ability of the soil to support heavy machinery. Operating machinery only during dry periods minimizes compaction and increases the seedling survival rate. The firm subsoil restricts the rooting depth of some plants. Because of the restricted rooting depth, windthrow is a hazard during storms. This hazard can be overcome by harvest methods that do not isolate the remaining trees or leave them widely spaced.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation. In areas where the surface stones are not removed, seedlings may need to be planted by hand.

The land capability classification is VIs, and the woodland ordination symbol is 4X.

1998—Warman Variant silty clay loam. This nearly level, very poorly drained soil is in shallow depressions, on flats, and in drainageways on outwash plains. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is very dark

gray silty clay about 4 inches thick. The subsoil is light brownish gray, mottled silty clay loam about 17 inches thick. The underlying material to a depth of about 60 inches is light gray silty clay. In some areas the subsoil and underlying material have a higher content of coarse fragments and a lower content of clay and silt.

Included with this soil in mapping are small areas of Markey and Oesterle soils. Markey soils have an organic layer that is 16 to 50 inches thick and are in landscape positions similar to those of the Warman Variant soil. Oesterle soils are somewhat poorly drained and are slightly higher on the landscape than the Warman Variant soil. Included soils make up about 5 to 14 percent of the unit.

Permeability is moderately slow or slow in the Warman Variant soil. The available water capacity is high. Surface runoff is very slow or ponded. The content of organic matter is moderate to very high. The seasonal water table is 2 feet above to 1 foot below the surface.

Most of the acreage is idle land. Some areas are used for hay or pasture. Abandoned clay mines or pits are in other areas.

This soil is generally unsuited to cultivated crops, hay, and pasture because of the wetness. Overgrazing when the soil is wet causes compaction. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of wetness. Seedling mortality is severe because of the very poor drainage. Cultivation or applications of herbicide help to remove competing vegetation.

The land capability classification is VIw. No woodland ordination symbol is assigned.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 290,000 acres in the survey area, or nearly 39 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county. The main crops grown on this land are corn and soybeans.

A recent trend in land use in areas near Little Falls has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify as prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1985, approximately 401,800 acres in Morrison County was used as cropland or pasture. About 148,500 acres of this land was used for corn, soybeans, or other row crops; 36,700 acres for small grain, including wheat, oats, and rye; and 216,600 acres for hay and pasture.

The paragraphs that follow describe the main concerns in managing the soils in the county for crops and pasture.

Soil blowing is a hazard on many of the soils in the county. The soils subject to soil blowing are nearly level soils that have closely spaced, shallow depressions and low convex rises. The factors that influence the susceptibility to soil blowing are texture of the surface layer, surface roughness, field size, and vegetative cover.

The soils in Morrison County that are most susceptible to soil blowing include Watab, Sartell, Pomroy, Zimmerman, and Soderville soils. These soils have a sandy surface layer, which reduces the stability of soil aggregates and increases the potential for soil blowing. Management measures to control soil blowing have little effect on the texture of the soil. Soil blowing can be controlled by measures that create a rough surface, reduce the size of the field, and establish a protective plant cover.

Wide fields allow soil blowing to reach maximum levels. Establishing field windbreaks or other vegetative barriers and wind stripcropping reduce the width of the field and thus help to control soil blowing. The local offices of the Soil Conservation Service and the Soil and Water Conservation District can assist in selecting

suitable species, in determining the proper location of field windbreaks, and in planning the layout of the stripcropping.

Managing crop residue can be one of the most cost-effective methods of controlling soil blowing. Tillage practices that leave part or all of the crop residue on the surface are very effective in controlling soil blowing. The residue can be managed by using a chisel plow, disk, or field cultivator. The primary tillage partially incorporates some of the residue into the soil. This measure leaves the surface rough and leaves some exposed soil to warm up and dry out in the spring, thus permitting timely secondary tillage and planting.

Conservation tillage is a form of crop residue management in which at least 30 percent of the surface is covered with residue after planting. Forms of conservation tillage include mulch-till, strip-till, ridge-till, and no-till. The factors that should be considered when a system of conservation tillage is selected include soil texture, drainage, slope, and the crop to be grown. Tillage methods that leave a small amount of crop residue on the surface and a ridge-till system of row cropping are effective on the somewhat poorly drained, poorly drained, and very poorly drained soils. Tillage methods that leave a large amount of crop residue on the surface, including strip-till and no-till, are most effective on moderately well drained, well drained, somewhat excessively drained, and excessively drained soils.

In addition to controlling erosion, other benefits of conservation tillage may include saving time, reducing fuel consumption, lowering equipment costs, conserving moisture, and improving wildlife habitat. The local offices of the Soil Conservation Service and the Cooperative Extension Service can assist in selecting suitable systems of conservation tillage for specific tracts.

Water erosion is a management concern on some of the cropland in the county. It is a hazard in the gently sloping or steeper areas of Cushing, Mahtomedi, Milaca, Flak, Emmert, and Pomroy soils. It is a very severe hazard on slopes that are more than 18 percent. Crop rotations, contour farming, terraces, and diversions are effective ways to reduce sheet and rill erosion. Some areas in the county, however, have short, irregular slopes that make application of these measures difficult. In these areas, a system of conservation tillage can help to control sheet and rill erosion and grassed waterways or water- and sediment-control basins can help to control erosion caused by concentrated waterflow.

Soil blowing and water erosion reduce the productivity of soils by removing plant nutrients and organic matter from the surface layer. As the thickness of the topsoil is reduced by erosion, part of the less fertile subsoil is incorporated into the plow layer. Erosion can be especially damaging to soils that have a surface layer of sandy loam and a low or moderate available water capacity. Examples are the Hubbard and Pomroy soils. Conservation practices that help to control erosion also increase the amount of moisture available to crops by reducing the runoff rate, by trapping and holding snow, and by increasing the rate of water infiltration.

Eroding sediments containing nutrients and pesticides are carried into ditches, streams, and lakes. Sediments deposited in ditches interfere with the drainage system. Removing these sediments is costly. Measures that control erosion minimize the pollution of streams and lakes and improve the quality of water for commercial and recreational uses and for fish and wildlife.

Wetness is the major limitation on approximately one-fourth of the cropland in the county. The poorly drained Parent and very poorly drained Rifle, Cathro, Isanti, Isan, Warman, and Prebish soils are naturally so wet that crop production is unlikely or impossible unless an adequate drainage system is installed. Draining the ponded areas of Isan, Prebish, Warman, and Rifle soils is often difficult because drainage outlets are not readily available.

Open field ditches commonly drain excess surface water. The major ditches also can be used as outlets for subsurface drainage tile lines. The spacing of subsurface drainage lines depends on the kind of soil and the depth at which drains can be installed.

Tilth is the physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration. Soils with good tilth are granular and porous. Soils with poor tilth have large clods, which interfere with seedbed preparation, seed germination and emergence, uptake of nutrients by plants, and the available water capacity. Excessively cultivating textured soils or cultivating them when they are wet results in deterioration of tilth and in surface compaction. Tilth can be improved by returning crop residue to the soil, applying livestock manure or other organic waste, growing green manure crops, and minimizing tillage.

Natural fertility is high in most soils in the county. It is medium, however, in Emmert, Hubbard, and Zimmerman soils. The response of crops to applications of fertilizer is good on most soils. The need for fertilizer depends on the kind of soil, past and present management, the degree of erosion, and the crop to be planted. A soil test can indicate the type and amount of

fertilizer to be applied. Crops do not respond so well to applications of fertilizer if the soil has such limitations as excessive wetness or droughtiness. All aspects of plant growth should be considered when planning a fertility management program.

Some soils in the county are irrigated with center-pivot irrigation systems. The most important irrigated crops are corn, soybeans, and potatoes. Hubbard, Duelm, and Menahga soils are the most commonly irrigated soils. Adequate amounts of good-quality water are generally available for irrigation.

Permanent pastures generally are located on land that is too wet, too steep, or too droughty for cultivation. Existing pastures can be improved by pasture rotation, applications of fertilizer, weed control, and deferment of grazing until the grasses reach a proper height or the soil dries out. In some areas pastures can be renovated by reseeding with more productive species. Species selection should be based on the kind of soil, the degree of wetness, and the planned period of grazing.

Well drained soils, such as Flak, Milaca, and Cushing soils, are suited to the widest range of cool-season forage species, including alfalfa, crownvetch, smooth bromegrass, timothy, and reed canarygrass. Also, these soils are well suited to big bluestem and switchgrass, which are warm-season grasses. Somewhat poorly drained or poorly drained soils, such as Growton, Freer, and Parent soils, also are well suited to these cool- and warm-season species.

Poorly drained and very poorly drained soils, such as Isan and Fordum soils, are suited to those species that can withstand the wetness. These species include reed canarygrass, creeping foxtail, redtop, birdsfoot trefoil, alsike clover, and ladino clover. If drained, these soils also are suitable for timothy, smooth bromegrass, Kentucky bluegrass, and red clover.

Moderately well drained soils, such as Osakis and Pomroy soils, usually produce forage in the spring and early summer and again in the fall, when precipitation is adequate. During the summer months droughty conditions limit production. Alfalfa, birdsfoot trefoil, smooth bromegrass, timothy, Kentucky bluegrass, and intermediate wheatgrass grow well on these soils when an adequate amount of moisture is available. Warm-season grasses, including big bluestem, little bluestem, and switchgrass, also grow well on these soils. If proper management is applied, these species provide good forage production during the summer. If included with cool-season species, they help to provide a full season of grazing.

Current information on species adaptation and variety selection can be obtained from the local offices of the Soil Conservation Service and the Cooperative Extension Service.

Yields per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped

at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Woodland Management and Productivity

Relatively undisturbed forest once covered almost all of Morrison County. At the turn of the century, however, the trees were harvested for use in the construction industry. Second- and third-growth forests are currently in areas that are unsuited to agriculture. With proper management, the soils in the county can produce trees for high-quality wood products.

In 1982, about 30 percent of the county, or 215,000 acres, was woodland. Of this acreage, about 50,000 acres was in the Camp Ripley Military Reserve and the rest was privately owned.

The woodland generally is in areas of well drained to excessively drained soils that have steep slopes and areas of poorly drained soils in depressions.

Thinning out mature trees and undesirable species or clearcutting in some areas could improve the woodland in the county. Protection from grazing and fire and control of diseases and insects also are needed to improve stands. Reforestation with adapted species could also improve forest growth in some areas. The Soil Conservation Service, the Minnesota Department of Natural Resources, and the Cooperative Extension Service can provide information about specific woodland management needs.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; *F*, a high content of rock fragments in the soil; and *L*, low strength. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, F, and L.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, and fire lanes and in log-handling areas. Forests that have been burned or overgrazed are also subject to erosion.

Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment and season of use are not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *productivity class*. The site index is the average height, in feet, that dominant or dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, natural stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *productivity class*, a number, is the yield likely to be produced by the most common trees. This number, expressed as cubic meters per hectare per year, indicates the amount of wood fiber produced on a fully stocked, even-aged, natural stand.

The species listed under *common trees* for a soil include the indicator species for that soil. The indicator species is the most common species and generally the most productive species on the soil. It is the species that determines the ordination class and is the first tree species listed unless marked by a double asterisk.

Trees to plant are those that are suitable for commercial wood production.

Windbreaks and Environmental Plantings

Since the days of the early settlers, windbreaks have been planted to protect farmsteads and livestock. In the 1930's, they were planted to control soil blowing and to trap snow in order to increase the moisture supply. Windbreaks also contribute to the beautification of areas and the establishment of wildlife habitat. In recent years some of the windbreaks in Morrison County have been removed during the installation of center-pivot irrigation systems. A conservation tillage system that includes good crop residue management helps to control the increased soil blowing that can occur when protective windbreaks are removed.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The

plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Morrison County offers a variety of recreational opportunities. The major public recreational areas in the county are Lindberg State Park, State-owned wildlife management land, natural conservancy land, and a county park.

Historical sites include the boyhood home of Charles Lindberg, the Weyerhauser Museum, and a former French fort adjacent to Little Falls. The county park site preserves remnants of the oxcart trail from Pembina to St. Paul.

An extensive system of trails for snowmobiling has been developed in the county. The State of Minnesota maintains boat access points on many of the lakes and streams in the county. Many of the smaller communities have baseball fields. Public golf courses are in Little Falls and Pierz.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Gary Johnson, wildlife manager, Minnesota Department of Natural Resources, Little Falls, helped prepare this section.

The number of wildlife and the diversity of species have changed since the county was first settled. The

continual changes in land use directly affect the diversity of species and the population density of wildlife. In the more intensively farmed areas of the county, wildlife habitat has been reduced to field edges, fence rows, and wet areas along marshes, ditches, and streams.

In spite of these changes, wildlife in the county include white-tailed deer, black bear, coyote, otter, mink, raccoon, bobcat, sandhill crane, ruffed grouse, pheasant, rabbits, hares, squirrels, weasels, red fox, gray fox, skunk, badger, beaver, Canada geese, owls, eagles, hawks, and many species of ducks, shorebirds, and songbirds.

The Mississippi River and its tributaries have significant populations of Canada geese, bald eagles, golden eagles, ospreys, great blue herons, river otters, minks, weasels, and deer.

Bunker Hill Creek and the West Branch of the Rum River have a limited population of brown trout. With good management the production of native trout in the county is possible. The county has approximately 15,204 acres of lake water. The population of the common fish species is good in the lakes.

Approximately 4,200 acres is available for public hunting in the county, in addition to the 54,000 acres in the Camp Ripley Military Reserve.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn and oats.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, and beggarweed.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, apple, hawthorn, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are

texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the "Glossary."

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features

are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possiblyincreased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent

effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the

engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of

about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

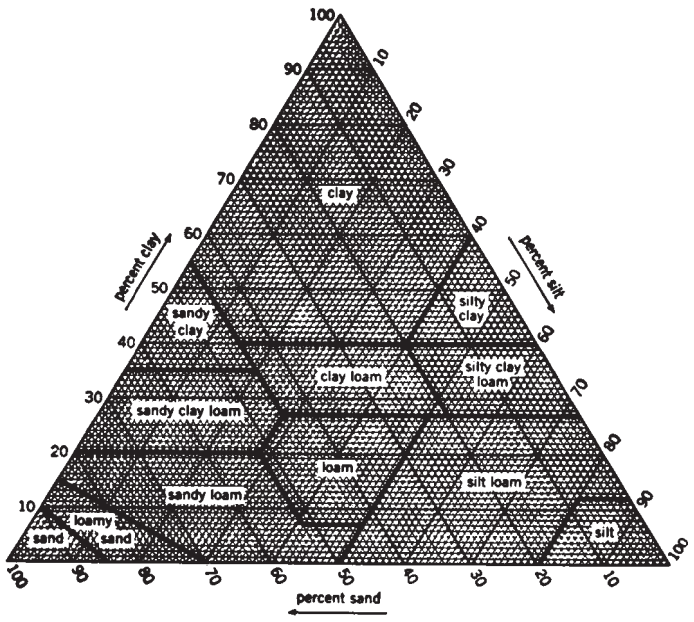

Figure 8.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 8). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the "Glossary."

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to

those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained

sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 16 shows total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of

corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

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Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(6)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Alfisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Boralf (*Bor*, meaning cool, plus *alf*, from Alfisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Eutroboralfs (*Eutro*, meaning fertile, plus *Boralf*, the suborder of the Alfisols that is cool).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Eutroboralfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is coarse-loamy, mixed Typic Eutroboralfs.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the underlying material can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" *(5)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(6)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Alstad Series

The Alstad series consists of somewhat poorly drained soils on uplands. These soils formed in loamy glacial till. Permeability is moderate in the upper part of the profile and moderately slow in the lower part.

Slopes range from 1 to 3 percent.

Typical pedon of Alstad loam, 2,640 feet south and 440 feet west of the northeast corner of sec. 31, T. 128 N., R. 31 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; many very fine roots; about 1 percent gravel; neutral; abrupt smooth boundary.

E—9 to 13 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; few fine distinct brown (7.5YR 5/4) mottles; weak thin platy structure; friable; many very fine roots; about 1 percent gravel; slightly acid; clear wavy boundary.

E/B—13 to 21 inches; dark grayish brown (10YR 4/2) loam (E) and brown (7.5YR 5/4) loam (Bt); common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; many very fine roots; about 1 percent gravel; moderately acid; clear wavy boundary.

Bt1—21 to 43 inches; brown (7.5YR 5/4) loam; common fine faint strong brown (7.5YR 5/6) and brown (7.5YR 5/2) mottles; moderate medium subangular blocky structure; friable; common very fine roots; few fine faint dark brown (7.5YR 3/2) clay films on faces of peds; about 5 percent gravel; moderately acid; clear wavy boundary.

Bt2—43 to 54 inches; brown (7.5YR 5/4) loam; many fine faint pinkish gray (7.5YR 6/2) and strong brown (7.5YR 5/8) mottles; moderate coarse subangular blocky structure; friable; few very fine roots; few fine faint dark brown (7.5YR 3/2) clay films on faces of peds; about 5 percent gravel; moderately acid; clear wavy boundary.

C—54 to 60 inches; brown (7.5YR 5/4) sandy loam; massive; firm; about 5 percent gravel; slightly acid.

The thickness of the solum ranges from 24 to 56 inches. The content of gravel ranges from 0 to 15 percent in the B and C horizons.

The Ap or A horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly loam, but the range includes sandy loam, fine sandy loam, and silt loam.

The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. It is dominantly loam, but the range includes sandy loam and silt loam.

The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is loam, sandy loam, fine sandy loam, or clay loam. The average content of clay in the control section ranges from 18 to 30 percent.

The C horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 4. It is sandy loam or fine sandy loam.

Arvilla Series

The Arvilla series consists of somewhat excessively drained soils on stream terraces and outwash plains. These soils formed in loamy outwash over sandy and gravelly outwash. Permeability is moderately rapid in the upper part of the profile and rapid or very rapid in the lower part. Slopes range from 0 to 6 percent.

Typical pedon of Arvilla sandy loam, 0 to 2 percent slopes, 2,600 feet east and 1,500 feet south of the northwest corner of sec. 9, T. 127 N., R. 30 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; friable; common fine roots; about 2 percent gravel; neutral; abrupt smooth boundary.

Bw—10 to 18 inches; dark brown (10YR 3/3) sandy loam; moderate medium subangular blocky structure; friable; few fine roots; about 5 percent gravel; neutral; clear wavy boundary.

2C1—18 to 36 inches; dark yellowish brown (10YR 4/4) gravelly coarse sand; single grain; loose; few fine roots; about 25 percent gravel; mildly alkaline; gradual wavy boundary.

2C2—36 to 60 inches; dark grayish brown (10YR 4/2) gravelly coarse sand; single grain; loose; about 30 percent gravel; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to sand and gravel range from 14 to 25 inches. The mollic epipedon ranges from 7 to 20 inches in thickness. The content of gravel ranges from 0 to 5 percent in the solum and from 5 to 35 percent in the 2C horizon.

The Ap or A horizon has value of 2 or 3 and chroma of 1. It is dominantly sandy loam, but the range includes loam and fine sandy loam.

The Bw horizon has hue of 2.5Y to 7.5YR, value of 2 to 4, and chroma of 1 to 3. It is dominantly sandy loam, but the range includes loam and fine sandy loam.

The 2C horizon has value of 4 or 5 and chroma of 2 to 4. It is gravelly coarse sand or coarse sand.

Becker Series

The Becker series consists of well drained, moderately rapidly permeable soils on flood plains. These soils formed in sandy alluvium. Slopes range from 0 to 2 percent.

The Becker soils in this county have a mean annual temperature that is colder than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Becker fine sandy loam, 2,600 feet north and 300 feet east of the southwest corner of sec. 22, T. 127 N., R. 29 W.

A1—0 to 15 inches; black (10YR 2/1) fine sandy loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; very friable; common medium roots; neutral; abrupt smooth boundary.

A2—15 to 32 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; friable; few fine roots; neutral; clear wavy boundary.

2Bw—32 to 36 inches; very dark grayish brown (10YR 3/2) loamy fine sand; weak fine subangular blocky structure; very friable; few very fine roots; mildly alkaline; clear wavy boundary.

2C—36 to 60 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; few very fine roots; mildly alkaline.

The thickness of the solum ranges from 24 to 48 inches. The mollic epipedon is 24 to 40 inches thick. The content of gravel ranges from 0 to 10 percent in the loamy mantle and from 0 to 25 percent in the underlying sandy sediments.

The A horizon has value of 2 or 3. It is dominantly fine sandy loam, but the range includes sandy loam and loam.

The 2Bw horizon, if it occurs, has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 or 3. It is loamy coarse sand, loamy sand, or loamy fine sand.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 to 4. It is coarse sand, sand, fine sand, loamy coarse sand, loamy sand, loamy fine sand, or the gravelly analogs of those textures.

Bowstring Series

The Bowstring series consists of very poorly drained soils on flood plains, outwash plains, and lake plains. These soils formed in highly decomposed organic material that is stratified with thin layers of sandy or loamy material. Permeability is moderately rapid to moderately slow. Slopes are 0 to 1 percent.

The Bowstring soils in this county are outside the range defined for the series because the total thickness of the organic layers is less than 51 inches. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Bowstring muck, 2,000 feet east and 2,600 feet south of the northwest corner of sec. 32, T. 129 N., R. 31 W.

Oa—0 to 4 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 15 percent fiber unrubbed, about 5 percent rubbed; massive; friable; primarily herbaceous fibers; about 5 percent mineral material; moderately acid; abrupt wavy boundary.

C—4 to 8 inches; grayish brown (2.5Y 5/2) and very dark gray (10YR 3/1) sand; single grain; loose; moderately acid; abrupt wavy boundary.

O'a1—8 to 34 inches; sapric material, black (N 2/0) broken face and rubbed; about 10 percent fiber unrubbed, about 5 percent rubbed; massive; friable; primarily herbaceous fibers; about 5 percent mineral material; moderately acid; gradual wavy boundary.

O'a2—34 to 41 inches; sapric material, black (N 2/0) broken face and rubbed; about 10 percent fiber unrubbed, about 5 percent rubbed; massive; friable; primarily herbaceous fibers; about 25 percent mineral material; moderately acid; abrupt wavy boundary.

C'—41 to 60 inches; grayish brown (2.5Y 5/2) sand; single grain; loose; slightly acid.

Depth to the C horizon ranges from 2 to 48 inches. The organic material has thin layers of mineral soil material.

The sapric material has hue of 5YR, 7.5YR, or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2.

The C and C' horizons have hue of 10YR, 2.5Y, or 5Y, value of 3 to 6, and chroma of 1 or 2. They are fine sand or loamy sand, but the range includes all sandy and loamy textures.

Brainerd Series

The Brainerd series consists of moderately well drained soils on drumlins and ground moraines. These soils formed in dense loamy glacial till. Permeability is moderately rapid or moderate in the upper part of the profile and slow or very slow in the lower part. Slopes range from 1 to 4 percent.

Typical pedon of Brainerd sandy loam, 1 to 4 percent slopes, 1,225 feet east and 100 feet south of the northwest corner of sec. 5, T. 41 N., R. 30 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; many medium roots; about 5 percent gravel; moderately acid; abrupt smooth boundary.

E—6 to 11 inches; brown (10YR 5/3) sandy loam, light gray (10YR 7/2) dry; common fine distinct brown (7.5YR 4/4) mottles; weak thin platy structure; friable; many fine roots; about 5 percent gravel; moderately acid; clear wavy boundary.

Bt1—11 to 15 inches; brown (7.5YR 4/4) sandy loam;

few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; few fine roots; common medium faint dark brown (7.5YR 4/2) clay films on faces of peds; about 10 percent gravel; moderately acid; clear wavy boundary.

Bt2—15 to 23 inches; brown (7.5YR 4/4) sandy loam; common medium faint brown (7.5YR 5/2) and common fine faint reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; friable; few fine roots; common medium faint dark brown (7.5YR 4/2) clay films on faces of peds; about 10 percent gravel; slightly acid; clear wavy boundary.

BC—23 to 41 inches; brown (7.5YR 4/4) sandy loam; common medium distinct strong brown (7.5YR 5/6) and common medium faint brown (7.5YR 5/2) mottles; moderate thin platy structure; firm; about 14 percent gravel; slightly acid; gradual wavy boundary.

Cd—41 to 60 inches; brown (7.5YR 4/4) sandy loam; few fine distinct reddish brown (5YR 4/4) mottles; massive, moderate thin platy soil fragments; firm; about 12 percent gravel; neutral.

The thickness of the solum and the depth to firm dense till range from 40 to 50 inches. The content of gravel in the upper part of the profile and in the Cd horizon ranges from 2 to 25 percent. The depth to bedrock ranges from 40 to more than 60 inches.

The Ap or A horizon has value of 2 to 4 and chroma of 1 to 3. It is dominantly sandy loam, but the range includes fine sandy loam and sandy loam. The content of stones ranges from 0 to 10 percent.

The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 4. It is sandy loam or fine sandy loam.

The Bt horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or fine sandy loam.

The BC and Cd horizons have hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 5. They are sandy loam or fine sandy loam.

Cathro Series

The Cathro series consists of very poorly drained soils on lake plains, outwash plains, and moraines. These soils formed in highly decomposed organic material overlying loamy sediments. Permeability is moderately rapid to moderately slow in the organic layers and moderate or moderately slow in the lower part of the profile. Slopes range from 0 to 2 percent.

Typical pedon of Cathro muck, 2,400 feet west and 300 feet south of the northeast corner of sec. 28, T. 127 N., R. 30 W.

Oa1—0 to 7 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 25 percent fiber unrubbed, about 8 percent rubbed; weak fine granular structure; very friable; primarily herbaceous fibers; strongly acid; clear wavy boundary.

Oa2—7 to 16 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 30 percent fiber unrubbed, 10 percent rubbed; weak fine granular structure; very friable; primarily herbaceous fibers; strongly acid; clear wavy boundary.

Oa3—16 to 25 inches; sapric material, black (7.5YR 2.5/0) broken face and rubbed; about 10 percent fiber unrubbed, 5 percent rubbed; very friable; primarily herbaceous fibers; moderately acid; clear wavy boundary.

AB—25 to 28 inches; black (7.5YR 2.5/0) fine sandy loam; massive; friable; moderately acid; clear wavy boundary.

C—28 to 60 inches; grayish brown (2.5Y 5/2) sandy loam; many coarse distinct gray (2.5Y 6/0) and many coarse prominent yellowish brown (10YR 5/8) mottles; massive; friable; slightly acid.

The thickness of the sapric material and the depth to the loamy material range from 16 to 50 inches. The organic material ranges from very strongly acid to moderately acid.

The sapric material has hue of 10YR, 7.5YR, or 5YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 3.

The C horizon has hue of 5YR, 7.5YR, 10YR, 2.5Y, 5GY, or 5Y or is neutral in hue. It has value of 4 to 6 and chroma of 0 to 3. It is sandy loam, fine sandy loam, very fine sandy loam, sandy clay loam, or loam.

Chetek Series

The Chetek series consists of somewhat excessively drained soils on stream terraces, outwash plains, and moraines. These soils formed in loamy material overlying sandy and gravelly outwash (fig. 9). Permeability is moderately rapid in the upper part of the profile and rapid or very rapid in the lower part. Slopes range from 2 to 15 percent.

Typical pedon of Chetek sandy loam, 2 to 8 percent slopes, 1,500 feet south and 400 feet west of the northeast corner of sec. 10, T. 42 N., R. 28 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) sandy loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; friable; common medium roots; about 5 percent gravel; moderately acid; abrupt smooth boundary.

E—6 to 10 inches; brown (10YR 5/3) sandy loam, very pale brown (10YR 7/3) dry; weak medium platy

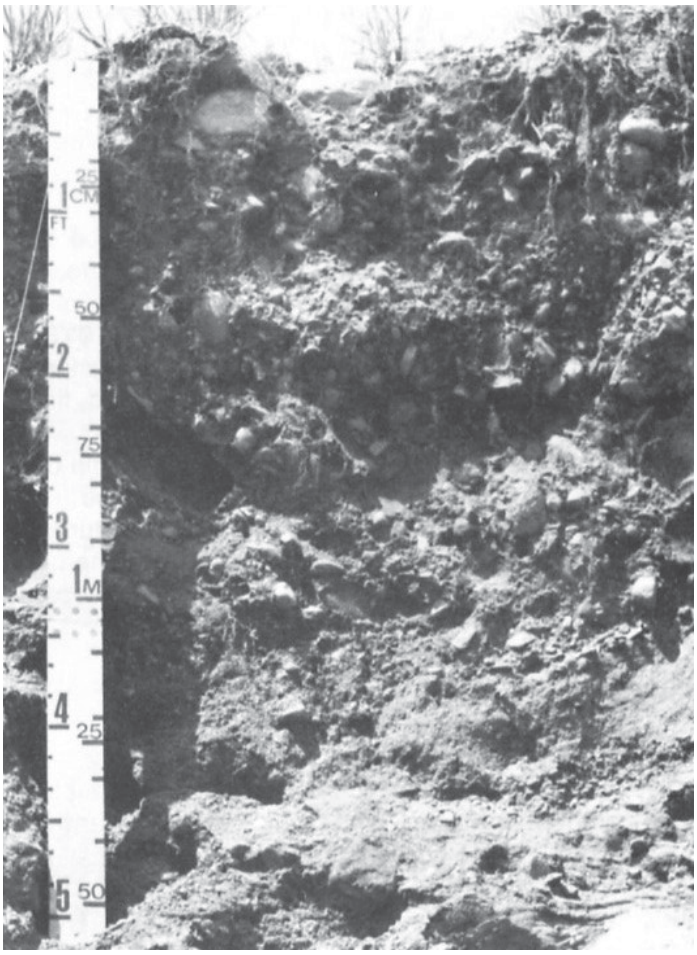

Figure 9.—Profile of Chetek soils, which formed in loamy material over sand and gravel.

structure; very friable; common medium roots; about 6 percent gravel; moderately acid; clear wavy boundary.

BE—10 to 14 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; few fine roots; about 9 percent gravel; moderately acid; clear wavy boundary.

Bt—14 to 20 inches; brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; few very fine roots; few faint dark reddish brown (5YR 3/4) clay films on faces of peds; about 14 percent gravel; moderately acid; clear wavy boundary.

2C—20 to 60 inches; brown (7.5YR 4/4) gravelly sand; single grain; loose; few very fine roots; about 30 percent gravel; strongly acid.

The thickness of the solum ranges from 12 to 24 inches. Some pedons have a 2Bt horizon. The content of gravel ranges from 0 to 15 percent in the A and Bt horizons and from 15 to 35 percent in the 2Bt2 and 2C horizons.

The Ap or A horizon has value of 3 or 4 and chroma of 2 or 3. It is sandy loam or loam.

The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. It is sandy loam or loam.

The BE horizon has hue of 10YR or 7.5YR and value and chroma of 3 or 4. It is sandy loam or loam.

The Bt horizon has hue of 7.5YR or 5YR and value and chroma of 3 or 4. It is sandy loam or loam.

The 2C horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 or 5, and chroma of 4 to 6.

Cushing Series

The Cushing series consists of well drained soils on moraines. These soils formed in loamy glacial till. Permeability is moderate in the upper part of the profile and moderately slow in the lower part. Slopes range from 2 to 30 percent.

Typical pedon of Cushing fine sandy loam, in an area of Cushing-Mahtomedi-DeMontreville complex, 8 to 15 percent slopes, 1,000 feet west and 50 feet north of the southeast corner of sec. 23, T. 133 N., R. 30 W.

A—0 to 5 inches; black (10YR 2/1) fine sandy loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; very friable; many medium roots; about 3 percent gravel; slightly acid; abrupt wavy boundary.

E1—5 to 13 inches; brown (10YR 5/3) fine sandy loam, light gray (10YR 7/2) dry; weak thin platy structure; very friable; many fine roots; about 4 percent gravel; strongly acid; clear wavy boundary.

E2—13 to 19 inches; brown (10YR 5/3) sandy loam, very pale brown (10YR 7/3) dry; weak thin platy structure; very friable; few fine roots; about 5 percent gravel; strongly acid; gradual wavy boundary.

B/E—19 to 29 inches; brown (7.5YR 4/4) sandy clay loam (Bt) and tongues of brown (10YR 5/3) sandy loam (E); weak medium subangular blocky structure; friable; few fine roots; about 8 percent gravel; moderately acid; clear wavy boundary.

Bt—29 to 42 inches; brown (7.5YR 4/4) sandy clay loam; moderate medium subangular blocky structure; firm; few fine roots; few fine faint reddish brown (5YR 4/3) clay films on faces of peds; about 10 percent gravel; moderately acid; clear wavy boundary.

C—42 to 60 inches; brown (7.5YR 4/4) sandy loam; massive; firm; about 10 percent gravel; slightly acid

The thickness of the solum ranges from 24 to 55 inches. The content of gravel ranges from 0 to 15 percent.

The A or Ap horizon has value of 2 to 4 and chroma of 1 to 3. It is dominantly fine sandy loam, but the range includes very fine sandy loam, sandy loam, and loam.

The E horizon has value of 4 to 6 and chroma of 2 or 3. It is fine sandy loam, loamy sand, sandy loam, or very fine sandy loam.

The Bt horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 5. It is fine sandy loam, sandy loam, loam, or sandy clay loam. The average content of clay in the control section ranges from 18 to 30 percent.

The C horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is fine sandy loam or sandy loam.

DeMontreville Series

The DeMontreville series consists of well drained soils on moraines. These soils formed in a sandy mantle and the underlying loamy glacial till. Permeability is rapid in the upper part of the profile and moderately slow in the lower part. Slopes range from 2 to 45 percent.

Typical pedon of DeMontreville loamy fine sand, in an area of Cushing-Mahtomedi-DeMontreville complex, 8 to 15 percent slopes, 125 feet east and 300 feet south of the northwest corner of sec. 23, T. 133 N., R. 30 W.

A—0 to 6 inches; very dark brown (10YR 2/2) loamy fine sand, gray (10YR 5/1) dry; weak fine subangular blocky structure; very friable; many medium roots; about 3 percent gravel; moderately acid; abrupt smooth boundary.

E—6 to 27 inches; brown (10YR 4/3) loamy sand, light gray (10YR 7/2) dry; weak fine subangular blocky structure; very friable; few fine roots; about 2 percent gravel; moderately acid; clear wavy boundary.

BE—27 to 33 inches; brown (7.5YR 4/4) loamy sand; moderate medium subangular blocky structure; friable; few fine roots; about 5 percent gravel; moderately acid; clear wavy boundary.

2Bt—33 to 46 inches; brown (7.5YR 4/4) sandy clay loam; moderate medium subangular blocky structure; firm; common fine faint reddish brown (5YR 4/4) clay films on faces of peds; about 8 percent gravel; moderately acid; clear wavy boundary.

2C—46 to 60 inches; brown (7.5YR 4/4) sandy loam; massive; firm; about 12 percent gravel; slightly acid.

The thickness of the solum ranges from 30 to 50 inches. The depth to firm glacial till ranges from 20 to 40 inches. The content of gravel ranges from 0 to 10 percent in the upper part of the profile and from 8 to 20 percent in the 2B and 2C horizons.

The A or Ap horizon has value of 2 to 4 and chroma of 1 to 3. It is dominantly loamy fine sand, but the range includes loamy sand, sand, and fine sand.

The E horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 or 3. It is loamy fine sand, loamy sand, sand, or fine sand.

The BE or B horizon, if it occurs, has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is loamy fine sand, loamy coarse sand, coarse sand, sand, fine sand, or loamy sand.

The 2Bt horizon has value of 3 to 5 and chroma of 3 to 6. It is sandy loam, sandy clay loam, loam, fine sandy loam, or the gravelly analogs of those textures.

The 2C horizon has value of 3 or 4 and chroma of 4 to 6. It is sandy loam, coarse sandy loam, loamy coarse sand, or the gravelly analogs of those textures.

Duelm Series

The Duelm series consists of somewhat poorly drained and moderately well drained, rapidly permeable soils on outwash plains. These soils formed in sandy outwash. Slopes range from 0 to 2 percent.

Typical pedon of Duelm loamy sand, 60 feet east and 90 feet north of the southwest corner of sec. 20, T. 128 N., R. 29 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loamy sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; many medium roots; about 2 percent gravel; slightly acid; abrupt smooth boundary.

A—7 to 11 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; many fine roots; about 2 percent gravel; slightly acid; clear smooth boundary.

Bw—11 to 17 inches; dark grayish brown (10YR 4/2) sand; few fine prominent light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; very friable; few fine roots; about 5 percent gravel; slightly acid; clear smooth boundary.

Bg—17 to 33 inches; dark grayish brown (10YR 4/2) coarse sand; common medium distinct brown (7.5YR 4/4) and common medium prominent gray (10YR 5/1 and 6/1) mottles; single grain; loose; few very fine roots; about 8 percent gravel; moderately acid; clear wavy boundary.

C—33 to 60 inches; light olive brown (2.5Y 5/4) coarse sand; common fine distinct grayish brown (2.5Y 5/2)

mottles; single grain; loose; about 8 percent gravel; moderately acid.

The thickness of the solum ranges from 32 to 60 inches. The mollic epipedon is 10 to 20 inches thick. The content of gravel ranges from 1 to 15 percent.

The Ap or A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loamy sand, but the range includes coarse sand, sand, and loamy coarse sand.

The Bw horizon has value of 3 to 5 and chroma of 2 or 3. It is loamy sand, coarse sand, sand, or loamy coarse sand.

The Bg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 or 3. It is loamy sand, coarse sand, sand, or loamy coarse sand.

The C horizon is loamy sand or coarse sand.

Emmert Series

The Emmert series consists of excessively drained, very rapidly permeable soils on outwash plains, eskers, terraces, and moraines. These soils formed in sandy outwash. Slopes range from 6 to 40 percent.

Typical pedon of Emmert gravelly loamy sand, 12 to 40 percent slopes, 1,000 feet north and 75 feet east of the southwest corner of sec. 21, T. 42 N., R. 28 W.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) gravelly loamy sand, grayish brown (10YR 5/2) dry; weak medium granular structure; very friable; many fine and medium roots; about 15 percent gravel; slightly acid; abrupt smooth boundary.

Bw—4 to 14 inches; dark yellowish brown (10YR 4/4) gravelly coarse sand; single grain; loose; few very fine roots; about 30 percent gravel; slightly acid; gradual wavy boundary.

C1—14 to 52 inches; brown (7.5YR 4/4) very gravelly coarse sand; single grain; loose; about 40 percent gravel; slightly acid; clear wavy boundary.

C2—52 to 60 inches; brown (7.5YR 4/4) very gravelly coarse sand; single grain; loose; about 45 percent gravel; neutral.

The thickness of the solum ranges from 12 to 30 inches. The content of gravel in the 10- to 40-inch control section ranges from 35 to 90 percent. Some gravel is concentrated in distinct strata.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is coarse sandy loam, sandy loam, fine sandy loam, loamy coarse sand, loamy sand, or the gravelly analogs of those textures. Some pedons have an E horizon.

The Bw horizon has hue of 5YR to 10YR, value of 3 to 5, and chroma of 2 to 6. It is gravelly coarse sand, gravelly sand, gravelly loamy coarse sand, or the very gravelly or extremely gravelly analogs of those textures.

The C horizon has hue of 5YR to 10YR, value of 3 to 5, and chroma of 3 to 6. It is gravelly coarse sand, gravelly sand, or the very gravelly or extremely gravelly analogs of those textures.

Flak Series

The Flak series consists of well drained soils on drumlins and ground moraines. These soils formed in dense loamy glacial till. Permeability is moderate or moderately rapid in the upper part of the profile and slow or very slow in the lower part. Slopes range from 4 to 25 percent.

Typical pedon of Flak sandy loam, 4 to 8 percent slopes, 100 feet east and 1,800 feet north of the southwest corner of sec. 22, T. 40 N., R. 30 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) sandy loam, pale brown (10YR 6/3) dry; weak fine granular structure; friable; many medium roots; about 2 percent gravel; very strongly acid; abrupt smooth boundary.

E—7 to 15 inches; brown (10YR 4/3) fine sandy loam; weak thin platy structure; friable; many fine roots; about 10 percent gravel; moderately acid; clear wavy boundary.

Bt—15 to 23 inches; brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; few fine roots; common medium faint dark brown (10YR 4/3) clay films on faces of peds; about 6 percent gravel; moderately acid; gradual wavy boundary.

BC—23 to 43 inches; brown (7.5YR 4/4) sandy loam; few fine faint strong brown (7.5YR 5/6) mottles; moderate medium platy structure; firm; about 12 percent gravel; moderately acid; gradual wavy boundary.

Cd—43 to 60 inches; brown (7.5YR 4/4) sandy loam; moderate medium platy soil fragments; firm; about 9 percent gravel; slightly acid.

The thickness of the solum ranges from 40 to 48 inches. The content of the gravel in the upper part of the profile and in the Cd horizon ranges from 2 to 20 percent.

The Ap or A horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly sandy loam, but the range includes fine sandy loam.

The E horizon has value of 4 or 5 and chroma of 2 or 3. It is sandy loam or fine sandy loam.

The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or fine sandy loam.

The BC horizon, if it occurs, has hue of 7.5YR or

10YR, value of 4 or 5, and chroma of 3 to 5. It is sandy loam or fine sandy loam.

The Cd horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 5. It is sandy loam, fine sandy loam, or the gravelly analogs of those textures.

Forada Series

The Forada series consists of poorly drained soils on outwash plains and valley trains. These soils formed in loamy sediments over sandy and gravelly material. Permeability is moderate or moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

The Forada soils in this county have more free carbonates in the upper 20 inches of the soil than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Forada loam, 900 feet west and 120 feet south of the northeast corner of sec. 10, T. 127 N., R. 31 W.

A1—0 to 12 inches; black (N 2/0) loam, very dark brown (10YR 2/2) dry; weak medium subangular blocky structure parting to weak fine granular; friable; many fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

A2—12 to 16 inches; very dark gray (10YR 3/1) sandy loam, very dark grayish brown (10YR 3/2) dry; common medium distinct dark grayish brown (2.5Y 4/2) mottles; weak medium subangular blocky structure; friable; few fine roots; about 1 percent gravel; slight effervescence; mildly alkaline; abrupt wavy boundary.

Bg—16 to 21 inches; brown (7.5YR 4/4) sandy loam; common medium prominent grayish brown (2.5Y 5/2) mottles; moderate medium subangular blocky structure; friable; few fine roots; about 5 percent gravel; slight effervescence; mildly alkaline; clear wavy boundary.

BCg—21 to 35 inches; grayish brown (2.5Y 5/2) loamy coarse sand; common medium distinct brown (10YR 5/3) mottles; weak fine subangular blocky structure; very friable; few fine roots; about 10 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

2C1—35 to 51 inches; grayish brown (2.5Y 5/2) coarse sand; single grain; loose; about 11 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

2C2—51 to 60 inches; light olive brown (2.5Y 5/4) sand; single grain; loose; about 5 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 40 inches. The mollic epipedon ranges from 12 to 24 inches in thickness. The content of gravel ranges from 0 to 10 percent in the upper sediments and from 0 to 35 percent in the 2C horizon.

The A horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is dominantly loam, but the range includes sandy loam, mucky sandy loam, and mucky loam.

The Bg horizon has hue of 7.5YR to 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, sandy loam, sandy clay loam, loamy sand, or loamy coarse sand.

The BC horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. It is loam, loamy coarse sand, loamy sand, sand, or coarse sand.

The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. It is sand, coarse sand, or the gravelly analogs of those textures.

Fordum Series

The Fordum series consists of poorly drained and very poorly drained soils on flood plains. These soils formed in recent sandy alluvium. Permeability is moderate or moderately rapid in the upper part of the profile and rapid or very rapid in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Fordum silt loam, in an area of Fordum-Winterfield complex, 1,600 feet south and 4,240 feet west of the northwest corner of sec. 17, T. 127 N., R. 29 W.

A—0 to 8 inches; black (10YR 2/1) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; many fine roots; slightly acid; clear smooth boundary.

C1—8 to 50 inches; very dark gray (10YR 3/1), stratified silt loam and fine sand, grayish brown (10YR 5/2) dry; few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; few fine roots; slightly acid; clear smooth boundary.

2C2—50 to 60 inches; grayish brown (10YR 5/2) sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; neutral.

The thickness of the solum ranges from 6 to 9 inches. The content of gravel ranges from 0 to 10 percent.

The A horizon has value of 2 or 3 and chroma of 0 to 3. It is dominantly silt loam, but the range includes loam, very fine sandy loam, sandy loam, fine sandy loam, and the mucky analogs of those textures.

The C horizon has hue of 5Y, 2.5Y, 10YR, or 7.5YR, or is neutral in hue. It has value of 3 to 5 and chroma of

0 to 3. It is silt loam, fine sand, or the mucky analogs of those textures.

The 2C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 1 to 4. It is sand, fine sand, loamy sand, or loamy fine sand.

Freeon Series

The Freeon series consists of moderately well drained soils on glacial drumlins and moraines. These soils formed in silty loess and the underlying dense loamy glacial till. Permeability is moderate in the upper part of the profile and slow or very slow in the lower part. Slopes range from 1 to 4 percent.

Typical pedon of Freeon silt loam, 1 to 4 percent slopes, 2,600 feet west and 550 feet south of the northeast corner of sec. 6, T. 39 N., R. 28 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; friable; many medium roots; about 2 percent gravel; strongly acid; abrupt smooth boundary.

E—7 to 15 inches; brown (10YR 5/3) very fine sandy loam, light gray (10YR 7/2) dry; weak thin platy structure; friable; many fine roots; about 2 percent gravel; strongly acid; clear wavy boundary.

E/B—15 to 20 inches; brown (10YR 5/3) very fine sandy loam (E) and tongues of brown (10YR 4/3) silt loam (Bt); weak thin platy structure; friable; few very fine roots; about 2 percent gravel; strongly acid; gradual wavy boundary.

Bt1—20 to 27 inches; brown (7.5YR 4/4) silt loam; few fine distinct yellowish red (5YR 4/6) mottles; weak thin platy structure; friable; few very fine roots; few fine faint dark brown (7.5YR 4/2) clay films on faces of peds; about 4 percent gravel; moderately acid; clear wavy boundary.

2Bt2—27 to 35 inches; brown (7.5YR 4/4) loam; few fine distinct yellowish red (5YR 4/6) mottles; moderate thin platy structure; firm; few fine faint dark brown (7.5YR 4/2) clay films on faces of peds; about 10 percent gravel; moderately acid; clear wavy boundary.

2Cd—35 to 60 inches; dark reddish brown (5Y 3/4) sandy loam; massive, moderate medium platy soil fragments; firm; about 12 percent gravel; moderately acid.

The thickness of the solum ranges from 24 to 40 inches. The thickness of the silty material ranges from 15 to 30 inches. The content of gravel is less than 5 percent in the A horizon and the upper part of the Bt horizon and is 5 to 20 percent in the 2Bt and 2Cd horizons.

The Ap or A horizon has value of 2 to 5 and chroma of 1 to 3. It is dominantly silt loam, but the range includes very fine sandy loam.

The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. It is silt loam or very fine sandy loam.

The Bt horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 3 to 6.

The 2Bt horizon has hue of 5YR, 7.5YR, or 2.5YR, value of 4 or 5, and chroma of 3 to 6. It is silt loam, loam, sandy loam, fine sandy loam, or the gravelly analogs of those textures.

The 2Cd horizon has hue of 2.5YR, 7.5YR, or 5YR and value and chroma of 3 to 5. It is sandy loam, gravelly sandy loam, fine sandy loam, clay loam, loamy sand, or loam.

Freer Series

The Freer series consists of somewhat poorly drained soils on drumlins and moraines. These soils formed in a mantle of silty sediments and in the underlying dense loamy glacial till. Permeability is moderate in the upper part of the profile and slow or very slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Freer silt loam, 2,300 feet north and 1,000 feet east of the southwest corner of sec. 12, T. 40 N., R. 28 W.

A—0 to 4 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium granular structure; very friable; common fine and medium roots; about 2 percent gravel; strongly acid; clear smooth boundary.

E—4 to 11 inches; grayish brown (10YR 5/2) silt loam, gray (10YR 6/1) dry; few fine distinct yellowish brown (10YR 5/4) mottles; moderate medium platy structure; very friable; common fine and medium roots; about 2 percent gravel; strongly acid; clear smooth boundary.

E/B—11 to 16 inches; grayish brown (10YR 5/2) silt loam (E) and tongues of yellowish brown (10YR 5/4) loam (Bt); common fine distinct brown (10YR 5/3) and many medium distinct yellowish brown (10YR 5/6) mottles; weak medium platy structure; friable; few fine roots; about 2 percent gravel; strongly acid; clear wavy boundary.

Bt1—16 to 22 inches; yellowish brown (10YR 5/4) loam; many medium distinct yellowish brown (10YR 5/6) and common fine distinct grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; few fine roots; many faint dark grayish brown (10YR 4/2) clay films on faces of peds; about

2 percent gravel; strongly acid; clear wavy boundary.
2Bt2—22 to 33 inches; brown (7.5YR 4/4) loam; weak thin platy structure; firm; few very fine roots; many fine faint dark grayish brown (10YR 4/2) clay films on faces of peds; about 8 percent gravel; moderately acid; clear wavy boundary.
2BC—33 to 44 inches; reddish brown (5YR 4/3) sandy loam; weak medium platy structure; firm; about 10 percent gravel; moderately acid; diffuse wavy boundary.
2Cd—44 to 60 inches; reddish brown (5YR 4/3) sandy loam; massive, moderate medium platy soil fragments; firm; about 10 percent gravel; moderately acid.

The thickness of the solum ranges from 40 to 54 inches. The thickness of the silty sediments ranges from 15 to 30 inches. The content of gravel ranges from 0 to 5 percent in the silty sediments and from 5 to 20 percent in the lower part of the profile. The average content of clay in the control section ranges from 18 to 28 percent.

The A or Ap horizon has value of 2 to 5 and chroma of 1 to 3. It is dominantly silt loam, but the range includes very fine sandy loam and loam that has a high content of very fine sand.

The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 1 to 3. It is silt loam, very fine sandy loam, or loam that has a high content of very fine sand.

The Bt horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 to 6. It is silt loam, very fine sandy loam, sandy loam, or loam. The average content of clay in the control section ranges from 18 to 28 percent.

The 2Bt horizon has hue of 7.5YR or 5YR, value of 4 to 6, and chroma of 2 to 6. It is silt loam, loam, fine sandy loam, or the gravelly analogs of those textures.

The 2BC and 2Cd horizons have hue of 7.5YR, 2.5YR, or 5YR and value and chroma of 3 to 5. They are sandy loam, fine sandy loam, or the gravelly analogs of those textures.

Greenwood Series

The Greenwood series consists of very poorly drained soils on moraines, till plains, lake plains, and outwash plains. These soils formed in deep organic deposits. Permeability is moderate to very rapid. Slopes range from 0 to 2 percent.

Typical pedon of Greenwood peat, 150 feet west and 200 feet north of the southeast corner of sec. 33, T. 41 N., R. 28 W.

Oi1—0 to 6 inches; fibric material, dark yellowish brown (10YR 3/4) broken face and rubbed; about 95 percent fiber unrubbed, about 90 percent rubbed; massive; primarily roots and sphagnum moss; extremely acid; clear smooth boundary.
Oi2—6 to 12 inches; fibric material, very dark brown (10YR 2/2) broken face and rubbed; about 90 percent fiber unrubbed, about 85 percent rubbed; massive; primarily roots and sphagnum moss; extremely acid; clear smooth boundary.
Oe1—12 to 30 inches; hemic material, very dark brown (10YR 2/2) broken face and rubbed; about 80 percent fiber unrubbed, about 45 percent rubbed; massive; primarily herbaceous fibers; extremely acid; gradual smooth boundary.
Oe2—30 to 60 inches; hemic material, very dark grayish brown (10YR 3/2) broken face and very dark brown (10YR 2/2) rubbed; about 80 percent fiber unrubbed, about 45 percent rubbed; massive; primarily herbaceous fibers; extremely acid.

The organic material is more than 51 inches thick. The surface layer is commonly fibric material derived from sphagnum moss, but the range includes stratified sapric and hemic material. The organic soil is extremely acid.

The Oe horizon has hue of 10YR, 7.5YR, or 5YR, value of 2 to 5, and chroma of 2 to 4.

Growton Series

The Growton series consists of moderately well drained and somewhat poorly drained, moderately rapidly permeable or moderately permeable soils on ground moraines and drumlins. These soils formed in loamy glacial till. Slopes range from 0 to 4 percent.

Typical pedon of Growton sandy loam, 2 to 4 percent slopes, 1,450 feet west and 100 feet north of the southeast corner of sec. 25, T. 127 N., R. 30 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; friable; many fine roots; about 5 percent gravel; slightly acid; abrupt smooth boundary.
E—9 to 19 inches; brown (10YR 4/3) sandy loam, pale brown (10YR 6/3) dry; common fine distinct brown (7.5YR 4/4) and few fine distinct grayish brown (10YR 5/2) mottles; weak thin platy structure; friable; few fine roots; about 5 percent gravel; moderately acid; clear wavy boundary.
Bt—19 to 44 inches; brown (7.5YR 4/4) sandy loam; common fine distinct strong brown (7.5YR 5/6) and brown (7.5YR 5/2) mottles; moderate medium subangular blocky structure; firm; few fine roots;

common fine faint dark brown (7.5YR 4/2) clay films on faces of peds; about 8 percent gravel; moderately acid; clear wavy boundary.
C—44 to 60 inches; dark yellowish brown (10YR 4/4) sandy loam; common fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 5 percent gravel; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 60 inches. The content of gravel ranges from 5 to 15 percent.

The Ap or A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly sandy loam, but the range includes fine sandy loam.

The E horizon has hue of 10YR or 7.5YR, value of 3 to 6, and chroma of 2 or 3. It is sandy loam, fine sandy loam, loamy sand, or loamy fine sand.

The Bt horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 to 4. It is sandy loam, fine sandy loam, or loam.

The C horizon has hue of 10YR, 7.5YR, or 2.5Y, value of 4 or 5, and chroma of 3 to 6. It is sandy loam or loam.

Holdingford Series

The Holdingford series consists of well drained, moderately permeable soils on ground moraines. These soils formed in loamy glacial till. Slopes range from 4 to 15 percent.

Typical pedon of Holdingford sandy loam, 4 to 8 percent slopes, 400 feet north and 200 feet east of the southwest corner of sec. 30, T. 127 N., R. 29 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) sandy loam, gray (10YR 5/1) dry; weak fine granular structure; very friable; many medium and fine roots; about 4 percent gravel; moderately acid; abrupt smooth boundary.
E1—8 to 13 inches; brown (10YR 4/3) sandy loam, pale brown (10YR 6/3) dry; weak thin platy structure; very friable; common fine roots; about 3 percent gravel; moderately acid; clear wavy boundary.
E2—13 to 17 inches; brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; friable; common fine roots; about 5 percent gravel; moderately acid; clear wavy boundary.
Bt1—17 to 29 inches; brown (7.5YR 4/4) sandy loam; weak thin platy structure; friable; few fine roots; few fine faint dark brown (10YR 4/3) clay films on faces of peds; about 8 percent gravel; strongly acid; clear smooth boundary.
Bt2—29 to 38 inches; brown (7.5YR 4/4) sandy loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium platy structure; firm; few very fine roots; few fine faint dark brown (10YR 4/3) clay films on faces of peds and lining pores; about 10 percent gravel; strongly acid; clear wavy boundary.
Bt3—38 to 49 inches; brown (7.5YR 4/4) sandy loam; weak medium platy structure; firm; few very fine roots; few fine faint dark brown (10YR 4/3) clay films on faces of peds and lining pores; about 11 percent gravel; slightly acid; clear smooth boundary.
C—49 to 60 inches; brown (10YR 4/3) sandy loam; weak medium platy structure; friable; about 10 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 26 to 60 inches. The content of gravel ranges from 2 to 15 percent.

The Ap or A horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly sandy loam, but the range includes fine sandy loam.

The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 4. It is sandy loam, fine sandy loam, loamy sand, or loamy fine sand.

The Bt horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is sandy loam, fine sandy loam, or loam.

The C horizon has value of 4 to 6 and chroma of 3 or 4. It is sandy loam, fine sandy loam, or loam.

Hubbard Series

The Hubbard series consists of excessively drained, rapidly permeable soils on outwash plains and valley trains. These soils formed in sandy outwash. Slopes range from 0 to 6 percent.

Typical pedon of Hubbard loamy sand, 2 to 6 percent slopes, 100 feet west and 1,850 feet south of the northeast corner of sec. 20, T. 39 N., R. 32 W.

Ap—0 to 9 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; many medium roots; about 2 percent gravel; strongly acid; abrupt smooth boundary.
A—9 to 14 inches; very dark brown (10YR 2/2) loamy sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; common medium and fine roots; about 2 percent gravel; moderately acid; clear wavy boundary.
Bw—14 to 22 inches; dark brown (10YR 3/3) sand; single grain; loose; few fine roots; about 3 percent gravel; moderately acid; clear wavy boundary.
BC—22 to 37 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; few fine roots; about 10

percent gravel; moderately acid; gradual wavy boundary.
C—37 to 60 inches; brown (10YR 5/3) sand; single grain; loose; few very fine roots; about 10 percent gravel; slightly acid.

The thickness of the solum ranges from 25 to 50 inches. The mollic epipedon is 10 to 26 inches thick. The content of gravel ranges from 0 to 10 percent.

The Ap and A horizons have value of 2 or 3. They are dominantly loamy sand, but the range includes sand, loamy coarse sand, and coarse sand.

The Bw and BC horizons have hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 to 4. They are loamy sand, sand, loamy coarse sand, or coarse sand.

The C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 5. It is loamy sand, coarse sand, or sand.

Isan Series

The Isan series consists of poorly drained and very poorly drained, rapidly permeable soils on outwash plains and valley trains. These soils formed in sandy outwash. Slopes are 0 to 1 percent.

Typical pedon of Isan sandy loam, 2,450 feet south and 750 feet west of the northeast corner of sec. 19, T. 128 N., R. 29 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; many medium roots; moderately acid; abrupt smooth boundary.
AB—8 to 13 inches; very dark gray (10YR 3/1) loamy sand, dark grayish brown (10YR 4/2) dry; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine subangular blocky structure; very friable; many medium and fine roots; moderately acid; clear wavy boundary.
Bg—13 to 25 inches; dark grayish brown (2.5Y 4/2) sand; common fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very friable; few fine roots; slightly acid; clear wavy boundary.
Cg—25 to 60 inches; grayish brown (2.5Y 5/2) coarse sand; common fine distinct gray (10YR 6/1) mottles; single grain; loose; moderately acid.

The thickness of the solum ranges from 15 to 30 inches. The mollic epipedon ranges from 10 to 24 inches in thickness. The control section is dominantly medium and coarse sand.

The Ap or A horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is sandy loam, coarse sandy loam, loamy sand, or loamy coarse sand.

The AB horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is loamy sand, loamy coarse sand, or sand.

The B horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 4 or 5 and chroma of 0 to 2. It is sand, coarse sand, loamy sand, or loamy coarse sand.

The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is coarse sand or sand.

Isanti Series

The Isanti series consists of poorly drained and very poorly drained, rapidly permeable soils on outwash plains and valley trains. These soils formed in sandy outwash or loess. Slopes range from 0 to 2 percent.

Typical pedon of Isanti fine sandy loam, 2,000 feet west and 1,200 feet north of the southeast corner of sec. 24, T. 132 N., R. 31 W.

A1—0 to 6 inches; black (N 2/0) fine sandy loam, very dark brown (10YR 2/2) dry; common medium prominent strong brown (7.5YR 5/8) mottles; weak fine granular structure; very friable; many medium roots; slightly acid; abrupt smooth boundary.
A2—6 to 16 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; few medium prominent yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; very friable; common medium roots; slightly acid; clear smooth boundary.
Bg1—16 to 22 inches; dark grayish brown (2.5Y 4/2) fine sand; few fine distinct dark yellowish brown (10YR 4/4) and dark reddish brown (5YR 3/4) mottles; single grain; loose; few fine roots; slightly acid; clear wavy boundary.
Bg2—22 to 29 inches; dark grayish brown (2.5Y 4/2) fine sand; few fine distinct grayish brown (10YR 5/2) mottles; single grain; loose; few fine roots; moderately acid; clear wavy boundary.
Bg3—29 to 34 inches; dark grayish brown (2.5Y 4/2) fine sand; few fine prominent yellowish brown (10YR 5/6) mottles; single grain; loose; few fine roots; moderately acid; clear wavy boundary.
Cg—34 to 60 inches; grayish brown (2.5Y 5/2) fine sand; few fine prominent yellowish brown (10YR 5/6) mottles; single grain; loose; moderately acid.

The thickness of the solum ranges from 20 to 40 inches. The mollic epipedon ranges from 10 to 18 inches in thickness.

The A horizon has hue of 10YR or 5Y. It is loamy fine sand, loamy sand, sandy loam, or the mucky analogs of those textures.

The Bg horizon has hue of 10YR, value of 4 or 5, and chroma of less than 1.5, has hue of 2.5Y or 5Y and chroma of 1 or 2, or is neutral in hue. It is fine sand, sand, loamy fine sand, or loamy sand.

The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 1 or 2. It is sand, fine sand, loamy sand, or loamy fine sand.

Mahtomedi Series

The Mahtomedi series consists of excessively drained, rapidly permeable soils on moraines and outwash plains. These soils formed in sandy outwash. Slopes range from 2 to 45 percent.

Typical pedon of Mahtomedi loamy sand, 8 to 15 percent slopes, 700 feet north and 300 feet west of the southeast corner of sec. 35, T. 131 N., R. 30 W.

A—0 to 5 inches; very dark gray (10YR 3/1) loamy sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; many medium roots; about 3 percent gravel; strongly acid; abrupt clear boundary.

E—5 to 10 inches; brown (10YR 4/3) sand, grayish brown (10YR 5/2) dry; single grain; loose; common medium roots; about 5 percent gravel; strongly acid; clear wavy boundary.

Bw1—10 to 27 inches; brown (7.5YR 4/4) gravelly sand; single grain; loose; few very fine roots; about 20 percent gravel; strongly acid; clear wavy boundary.

Bw2—27 to 35 inches; dark yellowish brown (10YR 4/4) coarse sand; single grain; loose; about 10 percent gravel; moderately acid; clear wavy boundary.

C—35 to 60 inches; yellowish brown (10YR 5/4) gravelly sand; single grain; loose; about 25 percent gravel; strongly acid.

The thickness of the solum ranges from 20 to 40 inches. The gravel in the control section averages 10 to 35 percent, by volume.

The A or Ap horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loamy sand, but the range includes coarse sand, sand, coarse sandy loam, and sandy loam.

The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 1 to 3. It is dominantly loamy sand, but the range includes coarse sand, sand, coarse sandy loam, sandy loam, and the gravelly analogs of those textures.

The Bw horizon has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5, and chroma of 4 to 6. It is coarse sand, sand, or the gravelly analogs of those textures.

The C horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 to 6, and chroma of 3 or 4. It is coarse sand, sand, or the gravelly analogs of those textures.

Markey Series

The Markey series consists of very poorly drained soils on outwash plains and ground moraines. These soils formed in highly decomposed organic deposits over sandy material. Permeability is moderately slow to moderately rapid in the organic layers and rapid in the underlying sandy material. Slopes range from 0 to 2 percent.

Typical pedon of Markey muck, 1,000 feet south and 800 feet west of the northeast corner of sec. 9, T. 127 N., R. 30 W.

Oa1—0 to 8 inches; sapric material, black (10YR 2/1) broken face and very dark brown (10YR 2/2) rubbed; about 15 percent fiber unrubbed, 2 percent rubbed; weak thin platy structure; primarily herbaceous fibers; slightly acid; clear wavy boundary.

Oa2—8 to 17 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 20 percent fiber unrubbed, less than 5 percent rubbed; weak thin platy structure; primarily herbaceous fibers; slightly acid; clear wavy boundary.

Oa3—17 to 26 inches; sapric material, black (7.5YR 2.5/0) broken face and rubbed; about 25 percent fiber unrubbed, 5 percent rubbed; weak medium platy structure; primarily herbaceous fibers; slightly acid; gradual wavy boundary.

Oa4—26 to 33 inches; sapric material, very dark gray (7.5YR 3/0) broken face and rubbed; about 10 percent fiber unrubbed, 2 percent rubbed; massive; primarily herbaceous fibers; neutral; abrupt smooth boundary.

Cg—33 to 60 inches; grayish brown (2.5Y 5/2) sand; single grain; loose; about 10 percent gravel; neutral.

The thickness of the sapric material and the depth to sandy material range from 16 to 50 inches. Some pedons have a 1- to 4-inch layer of sphagnum moss at the surface. The organic layers are strongly acid to slightly acid, and the C horizon is moderately acid to moderately alkaline.

The sapric material has hue of 10YR, 7.5YR, or 5YR or is neutral in hue. It has value of 2 to 4 and chroma of 0 to 3.

The C horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 4 to 6 and chroma of 0 to 4. It is sand, but the range includes fine sand, loamy sand, and thin layers of loamy material overlying the sandy material.

Meehan Series

The Meehan series consists of somewhat poorly drained, rapidly permeable soils on outwash plains and

stream terraces. These soils formed in sandy deposits. Slopes range from 0 to 2 percent.

Typical pedon of Meehan loamy sand, 65 feet north and 60 feet east of the center of sec. 18, T. 128 N., R. 29 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loamy sand, light brownish gray (10YR 6/2) dry; weak medium granular structure; very friable; common very fine and medium roots; about 1 percent gravel; slightly acid; abrupt smooth boundary.

E—7 to 13 inches; dark grayish brown (10YR 4/2) sand; common medium distinct dark reddish brown (5YR 3/2) mottles; weak medium subangular blocky structure; very friable; common fine roots; about 1 percent gravel; moderately acid; clear wavy boundary.

Bw—13 to 28 inches; brown (7.5YR 4/4) sand; common medium distinct pinkish gray (7.5YR 6/2), reddish brown (5YR 4/4), and yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; very friable; about 1 percent gravel; moderately acid; clear wavy boundary.

C—28 to 60 inches; grayish brown (10YR 5/2) coarse sand; many coarse distinct strong brown (7.5YR 5/6 and 5/8) mottles; single grain; loose; about 4 percent gravel; moderately acid.

The thickness of the solum ranges from 24 to 48 inches. The content of gravel ranges from 0 to 15 percent.

The Ap or A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loamy sand, but the range includes sand.

The E horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 or 3. It is dominantly loamy sand, but the range includes sand.

The Bw horizon has hue of 7.5YR, 10YR, or 5YR, value of 4 to 6, and chroma of 2 to 8. It is sand, coarse sand, or loamy coarse sand.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 7, and chroma of 2 to 4. It is sand or coarse sand.

Menahga Series

The Menahga series consists of excessively drained, rapidly permeable soils on outwash plains and valley trains. These soils formed in sandy outwash. Slopes range from 0 to 45 percent.

Typical pedon of Menahga loamy sand, 8 to 15 percent slopes, 3,000 feet east and 600 feet south of the northwest corner of sec. 18, T. 132 N., R. 31 W.

A—0 to 2 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; weak very fine granular structure; very friable; many very fine roots; about 1 percent gravel; strongly acid; abrupt smooth boundary.

AB—2 to 5 inches; very dark grayish brown (10YR 3/2) sand, brown (10YR 5/3) dry; weak very fine subangular blocky structure; very friable; common fine and very fine roots; about 1 percent gravel; strongly acid; clear wavy boundary.

Bw1—5 to 9 inches; brown (10YR 4/3) sand; single grain; loose; common fine and very fine roots; about 3 percent gravel; moderately acid; clear wavy boundary.

Bw2—9 to 14 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; common fine and very fine roots; about 4 percent gravel; moderately acid; clear wavy boundary.

BC—14 to 21 inches; yellowish brown (10YR 5/4) sand; single grain; loose; few fine and very fine roots; about 6 percent gravel; moderately acid; gradual wavy boundary.

C—21 to 60 inches; yellowish brown (10YR 5/4) coarse sand; single grain; loose; few very fine roots; about 6 percent gravel; moderately acid.

The thickness of the solum ranges from 20 to 46 inches. The content of gravel ranges from 0 to 15 percent.

The A and AB horizons have value of 2 or 3 and chroma of 1 or 2. They are dominantly loamy sand, but the range includes coarse sand, sand, and loamy coarse sand.

The Bw and BC horizons have hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. They are coarse sand, sand, or loamy coarse sand.

The C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6. It is coarse sand or sand.

Milaca Series

The Milaca series consists of well drained soils on drumlins and moraines. These soils formed in dense loamy glacial till. Permeability is moderate or moderately rapid in the upper part of the profile and slow or very slow in the lower part. Slopes range from 4 to 15 percent.

Typical pedon of Milaca fine sandy loam, 4 to 8 percent slopes, 100 feet west and 1,275 feet north of the southeast corner of sec. 35, T. 40 N., R. 28 W.

A—0 to 5 inches; very dark gray (10YR 3/1) fine sandy loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many medium roots; about 2 percent gravel; slightly acid; abrupt smooth boundary.

E—5 to 17 inches; brown (10YR 5/3) fine sandy loam, pale brown (10YR 6/3) dry; weak thin platy structure; very friable; many fine roots; about 5 percent gravel; strongly acid; clear wavy boundary.
EB—17 to 23 inches; brown (10YR 5/3) gravelly fine sandy loam; weak thin platy structure; very friable; few fine roots; about 20 percent gravel; strongly acid; gradual wavy boundary.
Bt—23 to 27 inches; reddish brown (5YR 4/4) gravelly sandy loam; moderate medium platy structure; friable; few fine faint dark reddish brown (5YR 3/3) clay films on faces of peds; about 15 percent gravel; strongly acid; gradual wavy boundary.
BC—27 to 36 inches; dark reddish brown (5YR 3/4) gravelly sandy loam; moderate medium platy structure; firm; few fine faint dark reddish brown (5YR 3/3) clay films on faces of peds; about 15 percent gravel; moderately acid; gradual wavy boundary.
Cd—36 to 60 inches; reddish brown (5YR 3/4) gravelly sandy loam; massive, moderate medium platy soil fragments; firm; about 15 percent gravel; slightly acid.

The thickness of the solum and the depth to firm till is 20 to 40 inches. The content of gravel ranges from 1 to 20 percent. The higher content of gravel is in the lower part of the solum.

The A or Ap horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly fine sandy loam, but the range includes very fine sandy loam, sandy loam, loam, and silt loam.

The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 4. It is fine sandy loam, very fine sandy loam, sandy loam, loam, or silt loam.

The Bt horizon has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 3 to 6. It is sandy loam, loam, or the gravelly analogs of those textures.

The BC horizon has hue of 5YR or 2.5YR, value of 3 to 5, and chroma of 3 or 4. It is sandy loam or gravelly sandy loam.

The Cd horizon has hue of 5YR or 2.5YR, value of 3 to 5, and chroma of 3 or 4. It is fine sandy loam, sandy loam, or the gravelly analogs of those textures.

Mora Series

The Mora series consists of moderately well drained soils on drumlins and moraines. These soils formed in dense loamy glacial till. Permeability is moderate or moderately rapid in the upper part of the profile and slow or very slow in the lower part. Slopes range from 1 to 4 percent.

Typical pedon of Mora fine sandy loam, 1 to 4 percent slopes, 1,950 feet east and 300 feet north of the southwest corner of sec. 28, T. 39 N., R. 29 W.

A—0 to 5 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate medium granular structure; very friable; many medium roots; about 2 percent gravel; moderately acid; abrupt smooth boundary.
E—5 to 11 inches; brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; weak thin platy structure; very friable; common medium roots; about 4 percent gravel; strongly acid; clear wavy boundary.
BE—11 to 17 inches; brown (7.5YR 5/4) fine sandy loam; common medium distinct brown (7.5YR 5/2) mottles; weak medium subangular blocky structure; friable; common fine roots; about 8 percent gravel; moderately acid; clear wavy boundary.
Bt—17 to 25 inches; yellowish red (5YR 5/6) gravelly fine sandy loam; common medium prominent reddish gray (5YR 5/2) and few fine prominent red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; friable; few fine roots; common medium distinct brown (7.5YR 4/2) clay films on faces of peds; about 15 percent gravel; moderately acid; abrupt wavy boundary.
BC—25 to 44 inches; yellowish red (5YR 4/6) fine sandy loam; common medium prominent reddish gray (5YR 5/2) and common medium distinct yellowish red (5YR 5/8) mottles; moderate medium platy structure; firm; about 12 percent gravel; moderately acid; clear wavy boundary.
Cd—44 to 60 inches; dark reddish brown (5YR 3/4) fine sandy loam; few fine distinct dark reddish gray (5YR 4/2) mottles; massive, moderate medium platy soil fragments; firm; about 10 percent gravel; moderately acid.

The thickness of the solum ranges from 40 to 50 inches. Depth to the firm till horizon ranges from 20 to 45 inches. The content of gravel ranges from 1 to 20 percent.

The A or Ap horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly fine sandy loam, but the range includes loam, sandy loam, and very fine sandy loam. The content of stones ranges from 0 to 10 percent.

The E horizon has value of 4 or 5 and chroma of 2 to 4. It is fine sandy loam or sandy loam.

The Bt horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is fine sandy loam, loam, sandy loam, or the gravelly analogs of those textures.

The BC horizon has hue of 2.5YR or 5YR, value of 3 to 5, and chroma of 3 to 6. It is fine sandy loam or sandy loam.

The Cd horizon has hue of 5YR or 2.5YR and value and chroma of 3 or 4. It is fine sandy loam or sandy loam.

Nokasippi Series

The Nokasippi series consists of very poorly drained soils on drumlins and ground moraines. These soils formed in a sandy mantle and the underlying dense loamy glacial till. Permeability is rapid in the upper part of the profile and slow or very slow in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Nokasippi mucky loamy fine sand, 200 feet west and 900 feet south of the northeast corner of sec. 20, T. 39 N., R. 31 W.

A—0 to 8 inches; black (10YR 2/1) mucky loamy fine sand, dark gray (10YR 4/1) dry; few fine prominent brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; very friable; many medium roots; about 2 percent gravel; strongly acid; abrupt smooth boundary.

AB—8 to 12 inches; very dark gray (10YR 3/1) loamy fine sand, dark gray (10YR4/1) dry; few fine prominent brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; very friable; common medium roots; about 2 percent gravel; moderately acid; abrupt wavy boundary.

Bg1—12 to 27 inches; grayish brown (2.5Y 5/2) loamy fine sand; few medium prominent brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; few fine roots; about 3 percent gravel; moderately acid; abrupt wavy boundary.

2Bg2—27 to 33 inches; grayish brown (2.5Y 5/2) gravelly sandy loam; many coarse prominent brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; few very fine roots; about 15 percent gravel; moderately acid; gradual wavy boundary.

2BC—33 to 48 inches; brown (7.5YR 4/4) sandy loam; many coarse distinct strong brown (7.5YR 5/6) and many medium prominent light brownish gray (10YR 6/2) mottles; weak thin and medium platy structure; firm; about 10 percent gravel; moderately acid; clear wavy boundary.

2Cd—48 to 60 inches; brown (7.5YR 4/4) gravelly sandy loam; few medium prominent light brownish gray (10YR 6/2) and few medium distinct strong brown (7.5YR 5/6) mottles; massive, moderate medium platy soil fragments; firm; about 15 percent gravel; slightly acid.

The thickness of the solum ranges from 40 to 50 inches. Depth to the firm till ranges from 20 to 48 inches. The mollic epipedon ranges from 10 to 16 inches in thickness. The content of gravel is 0 to 2 percent in the A and E horizons and 8 to 20 percent in the 2B and 2Cd horizons.

The A and AB horizons have value of 2 or 3 and chroma of 1. They are dominantly mucky loamy fine sand, but the range includes loamy sand, sandy loam, fine sandy loam, and the mucky analogs of those textures.

The B horizon and the upper part of the 2B horizon have hue of 10YR, value of 4 or 5, and chroma of 1 or have hue of 2.5Y and chroma of 2. They are fine sand, sand, or loamy sand.

The 2B horizon has hue of 7.5YR or 5YR and value and chroma of 3 to 5. It is loam, sandy loam, or fine sandy loam.

The 2BC horizon has hue of 7.5YR or 5YR and value and chroma of 3 to 5. It is sandy loam or fine sandy loam.

The 2Cd horizon has hue of 7.5YR or 5YR and value and chroma of 3 to 5.

Nokay Series

The Nokay series consists of somewhat poorly drained soils on drumlins and ground moraines. These soils formed in dense loamy glacial till. Permeability is moderate or moderately rapid in the upper part of the profile and slow or very slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Nokay loam, 1,300 feet south and 1,900 feet west of the northeast corner of sec. 12, T. 42 N., R. 30 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium granular structure; friable; many medium roots; about 2 percent gravel; strongly acid; abrupt smooth boundary.

E—6 to 14 inches; grayish brown (10YR 5/2) fine sandy loam, pale brown (10YR 6/3) dry; common fine distinct yellowish brown (10YR 5/6) mottles; weak thin platy structure; friable; many medium roots; about 2 percent gravel; strongly acid; clear wavy boundary.

Bt1—14 to 23 inches; brown (7.5YR 4/4) sandy loam; many medium distinct light brownish gray (10YR 6/2) coatings on faces of peds; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium platy structure; friable; common medium roots; few fine distinct dark reddish brown (5YR 4/4) clay films on faces of peds; about 4 percent gravel; strongly acid; clear wavy boundary.

Bt2—23 to 31 inches; brown (7.5YR 4/4) sandy loam; many medium distinct light brownish gray (10YR

6/2) coatings on faces of peds; common fine distinct strong brown (7.5YR 5/6) mottles; weak medium platy structure; friable; few fine roots; few fine distinct dark reddish brown (5YR 4/4) clay films on faces of peds; about 7 percent gravel; moderately acid; clear wavy boundary.

BC—31 to 41 inches; brown (7.5YR 4/4) sandy loam; common fine distinct strong brown (7.5YR 5/6) and few fine prominent dark red (2.5YR 3/6) mottles; moderate medium platy structure; firm; about 10 percent gravel; slightly acid; gradual wavy boundary.

Cd—41 to 60 inches; brown (7.5YR 4/4) sandy loam; few fine faint strong brown (7.5YR 5/6) mottles; massive, moderate medium platy soil fragments; firm; about 6 percent gravel; slightly acid.

The thickness of the solum ranges from 40 to 60 inches. Depth to the firm till ranges from 20 to 42 inches. The content of gravel in the upper part of the profile and in the Cd horizon ranges from 2 to 25 percent.

The Ap or A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loam, but the range includes sandy loam, fine sandy loam, and loam. The content of stones ranges from 0 to 10 percent.

The E horizon has value of 4 to 6 and chroma of 1 or 2. It is sandy loam, fine sandy loam, or loam.

The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 to 6. It is sandy loam, fine sandy loam, or loam.

The BC and Cd horizons have value of 4 or 5 and chroma of 3 to 5. They are sandy loam or fine sandy loam.

Oesterle Series

The Oesterle series consists of somewhat poorly drained soils on outwash plains and stream terraces. These soils formed in loamy deposits over sandy and gravelly materials. Permeability is moderate or moderately rapid in the upper part of the profile and rapid or very rapid in the lower part. Slopes range from 0 to 3 percent.

Typical pedon of Oesterle sandy loam, 0 to 1 percent slopes, 1,200 feet east and 740 feet north of the southwest corner of sec. 23, T. 42 N., R. 28 W.

Ap—0 to 6 inches; very dark brown (10YR 2/2) sandy loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; many medium roots; about 8 percent gravel; slightly acid; abrupt smooth boundary.

E/B—6 to 9 inches; grayish brown (10YR 5/2) sandy loam (E) and brown (7.5YR 4/4) sandy loam (Bt); weak fine subangular blocky structure; friable; many fine roots; about 10 percent gravel; slightly acid; clear wavy boundary.

Bt1—9 to 17 inches; brown (7.5YR 4/4) sandy loam; many coarse distinct brown (7.5YR 5/2) and pinkish gray (7.5YR 6/2) mottles; weak medium subangular blocky structure; friable; few fine roots; many medium distinct dark reddish brown (5YR 3/4) clay films on faces of peds; about 10 percent gravel; slightly acid; clear wavy boundary.

Bt2—17 to 23 inches; brown (7.5YR 4/4) sandy loam; common coarse distinct pinkish gray (7.5YR 4/4) mottles; weak fine subangular blocky structure; friable; few fine roots; colloid in bridges between mineral grains; about 12 percent gravel; moderately acid; clear wavy boundary.

2C1—23 to 29 inches; reddish brown (5YR 4/4) very gravelly coarse sand; single grain; loose; about 60 percent gravel; moderately acid; gradual wavy boundary.

2C2—29 to 60 inches; reddish brown (5YR 4/4) very gravelly sand; single grain; loose; about 40 percent gravel; moderately acid.

The thickness of the solum ranges from 20 to 40 inches. The content of gravel ranges from 0 to 15 percent in the A and E/B horizons, from 0 to 35 percent in the B horizon, and from 5 to 60 percent in the 2C horizon.

The Ap or A horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly sandy loam, but the range includes fine sandy loam, very fine sandy loam, silt loam, and loam.

The Bt horizon has hue of 10YR or 7.5YR and value and chroma of 4 to 6. It is sandy loam, fine sandy loam, loam, or the gravelly analogs of those textures.

The 2C horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 to 6, and chroma of 1 to 8. It is sand, coarse sand, loamy sand, or the gravelly analogs of those textures.

Osakis Series

The Osakis series consists of moderately well drained soils on outwash plains. These soils formed in outwash. Permeability is moderate or moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

The Osakis soils in this county have a textural change in the control section that is more abrupt than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Osakis loam, 2,225 feet north and 60 feet east of the southwest corner of sec. 11, T. 127 N., R. 30 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; common very fine roots; about 1 percent gravel; slightly acid; abrupt smooth boundary.

Bw—10 to 19 inches; dark brown (10YR 4/3) loam; few fine faint dark grayish brown (10YR 4/2) and common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few very fine roots; about 2 percent gravel; slightly acid; clear wavy boundary.

2BC—19 to 23 inches; brown (10YR 5/3) sand; common fine faint grayish brown (10YR 5/2) and common medium prominent yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; loose; about 5 percent gravel; slightly acid; clear wavy boundary.

2C1—23 to 27 inches; grayish brown (10YR 5/2) gravelly sand; single grain; loose; about 15 percent gravel; slight effervescence; mildly alkaline; clear wavy boundary.

2C2—27 to 60 inches; dark grayish brown (10YR 4/2) gravelly coarse sand; single grain; loose; about 25 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 16 to 25 inches. The content of gravel ranges from 0 to 10 percent in the upper sediments and from 10 to 70 percent in the lower sediments but averages less than 35 percent in the control section.

The Ap or A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loam, but the range includes sandy loam.

The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 to 4. It is loam or sandy loam.

The 2BC horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. It is sand, coarse sand, loamy coarse sand, or loamy sand.

The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 or 3. It is sand, coarse sand, loamy coarse sand, or loamy sand.

Parent Series

The Parent series consists of poorly drained soils on moraines. These soils formed in a loamy mantle and dense loamy glacial till. Permeability is moderate in the upper part of the profile and slow or very slow in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Parent loam, 2,400 feet east and 350 feet north of the southwest corner of sec. 35, T. 40 N., R. 30 W.

A—0 to 10 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; many medium roots; about 5 percent gravel; neutral; clear wavy boundary.

ABg—10 to 15 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; common medium and fine roots; about 5 percent gravel; neutral; clear wavy boundary.

Bg1—15 to 21 inches; dark grayish brown (2.5Y 4/2) loam; few fine prominent strong brown (7.5YR 5/6) and many fine faint grayish brown (2.5Y 5/2) mottles; moderate medium subangular blocky structure; friable; common fine roots; about 5 percent gravel; neutral; clear wavy boundary.

Bg2—21 to 26 inches; grayish brown (2.5Y 5/2) sandy loam; common large prominent brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; friable; few fine roots; about 14 percent gravel; moderately acid; clear wavy boundary.

2BC—26 to 40 inches; brown (7.5YR 4/4) sandy loam; few medium distinct strong brown (7.5YR 5/6) and common large prominent light olive gray (5Y 6/2) mottles; weak thin platy structure; firm; about 14 percent gravel; moderately acid; clear wavy boundary.

2Cd—40 to 60 inches; brown (7.5YR 4/4) sandy loam; common medium prominent light olive gray (5Y 6/2) mottles; massive, moderate thin platy soil fragments; firm; about 14 percent gravel; moderately acid.

The thickness of the solum ranges from 40 to 50 inches. Depth to the firm or very firm till ranges from 20 to 35 inches. The content of gravel ranges from 2 to 8 percent in the upper part of the profile and from 5 to 15 percent in the lower part and in the Cd horizon. The mollic epipedon is 10 to 18 inches thick.

The A or Ap horizon has hue of 10YR or is neutral in hue. It has value of 2 and chroma of 0 or 1. It is dominantly loam, but the range includes fine sandy loam, sandy loam, and silt loam. The content of stones ranges from 0 to 10 percent.

The AB horizon has hue of 10YR or is neutral in hue. It has value of 3 and chroma of 0 or 1. It is loam, fine sandy loam, sandy loam, or silt loam. The content of stones ranges from 0 to 10 percent.

The Bg horizon has hue of 2.5Y, 10YR, or 7.5YR, value of 4 or 5, and chroma of 1 or 2. It is loam, sandy loam, fine sandy loam, or loam.

The 2BC horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. It is loam, sandy loam, or fine sandy loam.

The 2Cd horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. It is sandy loam or fine sandy loam.

Pierz Series

The Pierz series consists of well drained soils on outwash plains and valley trains. These soils formed in a loamy mantle over sandy and gravelly sediments. Permeability is moderate or moderately rapid in the upper part of the profile and rapid or very rapid in the lower part. Slopes range from 0 to 6 percent.

Typical pedon of Pierz sandy loam, 0 to 2 percent slopes, 800 feet west and 1,200 feet south of the northeast corner of sec. 29, T. 41 N., R. 30 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; friable; many medium roots; about 3 percent gravel; slightly acid; abrupt smooth boundary.

AB—10 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; friable; many fine roots; about 3 percent gravel; slightly acid; clear wavy boundary.

Bt—14 to 23 inches; brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; common distinct dark yellowish brown (10YR 3/4) clay films on faces of peds; about 8 percent gravel; moderately acid; gradual wavy boundary.

BC—23 to 28 inches; brown (7.5YR 4/4) sandy loam; weak fine subangular blocky structure; friable; few fine roots; about 10 percent gravel; strongly acid; gradual wavy boundary.

2C—28 to 60 inches; brown (7.5YR 4/4) very gravelly coarse sand; single grain; loose; few very fine roots; about 40 percent gravel; strongly acid.

The thickness of the solum and the depth to gravelly sediments range from 22 to 40 inches. The content of gravel ranges from 0 to 20 percent in the loamy mantle and from 15 to 60 percent in the lower part of the profile. The mollic epipedon is 8 to 16 inches thick.

The Ap and AB horizons have hue of 10YR or 7.5YR and value of 2 or 3. They are dominantly sandy loam, but the range includes loam and fine sandy loam.

The Bt and BC horizons have hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 3 to 6. They are sandy loam, loam, fine sandy loam, or the gravelly analogs of those textures.

The 2C horizon has hue of 7.5YR, 5YR, or 10YR, value of 3 to 5, and chroma of 3 to 6. It is sandy loam, very gravelly coarse sand, gravelly coarse sand, very gravelly sand, or gravelly sand.

Pomroy Series

The Pomroy series consists of well drained and moderately well drained soils on drumlins and ground moraines. These soils formed in a sandy mantle of eolian or lacustrine deposits and dense loamy glacial till. Permeability is rapid in the upper part of the profile and moderately slow or very slow in the lower part. Slopes range from 1 to 12 percent.

Typical pedon of Pomroy loamy fine sand, 1 to 6 percent slopes, 480 feet east and 100 feet south of the northwest corner of sec. 30, T. 39 N., R. 30 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; massive; very friable; many medium roots; moderately acid; abrupt smooth boundary.

E—9 to 20 inches; brown (10YR 4/3) loamy fine sand; weak fine subangular blocky structure; friable; many fine roots; moderately acid; clear wavy boundary.

BE—20 to 26 inches; brown (7.5YR 4/4) loamy fine sand; weak fine subangular blocky structure; friable; few fine roots; moderately acid; clear wavy boundary.

2Bt—26 to 42 inches; brown (7.5YR 4/4) sandy loam; weak thin platy structure; firm; about 12 percent gravel; few fine faint brown (10YR 4/3) clay films on faces of peds; moderately acid; gradual wavy boundary.

2Cd—42 to 60 inches; brown (7.5YR 4/4) sandy loam; massive, moderate thin platy soil fragments; firm; about 14 percent gravel; moderately acid.

The thickness of the solum ranges from 40 to 50 inches. The sandy mantle ranges from 20 to 40 inches in thickness. The content of gravel ranges from 0 to 2 percent in the A and E horizons and from 5 to 20 percent in the 2B and 2Cd horizons.

The Ap or A horizon has value of 2 to 4 and chroma of 1 to 3. It is dominantly loamy fine sand, but the range includes fine sand, loamy sand, and sand.

The E horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. It is dominantly loamy fine sand, fine sand, or sand.

The 2Bt horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is fine sandy loam, sandy loam, or the gravelly analogs of those textures.

The 2Cd horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is sandy loam, fine sandy loam, or the gravelly analogs of those textures.

Prebish Series

The Prebish series consists of very poorly drained soils on till plains and moraines. These soils formed in

a loamy mantle over firm loamy glacial till. Permeability is moderate or moderately slow in the upper part of the profile and moderately slow in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Prebish loam, 780 feet west and 1,300 feet north of the southeast corner of sec. 36, T. 40 N., R. 30 W.

A1—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; very friable; many medium roots; about 2 percent gravel; neutral; abrupt smooth boundary.

A2—7 to 13 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; few fine distinct very dark gray (2.5Y 3/0) mottles; moderate medium subangular blocky structure; friable; common fine roots; about 3 percent gravel; neutral; abrupt smooth boundary.

Bg1—13 to 21 inches; grayish brown (2.5Y 5/2) fine sandy loam; common medium prominent strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; friable; few fine roots; about 3 percent gravel; neutral; clear wavy boundary.

Bg2—21 to 42 inches; grayish brown (2.5Y 5/2) fine sandy loam; many medium prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; few fine roots; about 6 percent gravel; neutral; clear wavy boundary.

2C—42 to 60 inches; brown (7.5YR 5/4) sandy loam; many medium prominent light olive brown (2.5Y 5/6) and brown (7.5YR 5/2) mottles; weak thin platy structure; firm; about 8 percent gravel; neutral.

The thickness of the solum and the depth to the firm or very firm 2C horizon ranges from 40 to more than 60 inches. The mollic epipedon ranges from 10 to 18 inches in thickness. The content of gravel ranges from 2 to 8 percent in the solum and from 5 to 18 percent in the 2C horizon.

The A horizon has value of 2 or 3. It is dominantly loam, but the range includes sandy loam and fine sandy loam.

The upper part of the B horizon has hue of 10YR, value of 4 to 6, and chroma of 1, or it has hue of 2.5Y or 5Y and chroma of 2 or less. The lower part has hue of 5YR, 10YR, or 2.5Y, value of 4 or 5, and chroma of 3 or less. This horizon is loam, coarse sandy loam, fine sandy loam, or sandy loam.

The 2C horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is coarse sandy loam, sandy loam, fine sandy loam, or the gravelly analogs of those textures.

Rifle Series

The Rifle series consists of very poorly drained soils on outwash plains, lake plains, till plains, and moraines. These soils formed in organic deposits. Permeability is moderate or moderately rapid. Slopes range from 0 to 2 percent.

Typical pedon of Rifle muck, 2,350 feet west and 250 feet south of the northeast corner of sec. 30, T. 130 N., R. 30 W.

Oa—0 to 7 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 25 percent fiber unrubbed, about 8 percent rubbed; massive; primarily herbaceous fibers; moderately acid; abrupt smooth boundary.

Oe1—7 to 24 inches; hemic material, black (5YR 2/1) broken face and dark reddish brown (5YR 2/2) rubbed; about 80 percent fiber unrubbed, 30 percent rubbed; weak medium platy structure; primarily herbaceous fibers; moderately acid; gradual smooth boundary.

Oe2—24 to 29 inches; hemic material, dark reddish brown (5YR 2/2) broken face and rubbed; about 90 percent fiber unrubbed, 35 percent rubbed; massive; primarily herbaceous fibers; moderately acid; gradual smooth boundary.

Oe3—29 to 60 inches; hemic material, black (5YR 2/1) broken face and rubbed; about 85 percent fiber unrubbed, 25 percent rubbed; massive; primarily herbaceous fibers; slightly acid.

The organic soil material is more than 51 inches thick. The organic material is mainly of herbaceous origin, but some pedons have as much as 15 percent woody fragments, by volume. Layers of fibric or sapric material within the subsurface layer and bottom layers are 0 to 10 inches thick. Reaction ranges from strongly acid to neutral throughout the profile.

The surface layer has hue of 10YR to 5YR, value of 2 to 6, and chroma of 1 to 4. The subsurface layer and bottom layers have hue of 10YR, 7.5YR, or 5YR and value and chroma of 2 to 4.

Ronneby Series

The Ronneby series consists of somewhat poorly drained soils on drumlins and moraines. These soils formed in dense loamy glacial till. Permeability is moderate or moderately rapid in the upper part of the profile and slow or very slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Ronneby loam, 100 feet east and 2,200 feet north of the southwest corner of sec. 33, T. 41 N., R. 28 W.

A—0 to 5 inches; black (10YR 2/1) loam, gray (10YR 5/1) dry; weak fine and medium granular structure; very friable; many medium roots; about 10 percent gravel; moderately acid; abrupt smooth boundary.
E—5 to 11 inches; dark grayish brown (10YR 4/2) fine sandy loam, light gray (10YR 7/2) dry; common medium prominent yellowish red (5YR 4/6) and common medium faint grayish brown (10YR 5/2) mottles; weak thin platy structure; friable; common medium roots; about 14 percent gravel; slightly acid; clear wavy boundary.
BE—11 to 15 inches; brown (7.5YR 5/2) sandy loam; common medium prominent strong brown (7.5YR 5/6) and common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium platy structure; friable; few medium and fine roots; about 10 percent gravel; moderately acid; clear wavy boundary.
Bt1—15 to 23 inches; brown (7.5YR 5/4) sandy loam; common coarse distinct brown (7.5YR 5/2) mottles; moderate medium platy structure; friable; few fine and medium roots; few fine faint patchy reddish brown (2.5YR 4/4) clay films on faces of peds; about 10 percent gravel; moderately acid; clear wavy boundary.
Bt2—23 to 32 inches; reddish brown (5YR 4/4) sandy loam; common medium distinct pinkish gray (5YR 6/2) mottles; moderate medium platy structure; firm; few fine roots; few fine faint patchy reddish brown (2.5YR 4/4) clay films on faces of peds; about 12 percent gravel; slightly acid; clear wavy boundary.
BC—32 to 45 inches; dark reddish brown (5YR 3/4) sandy loam; common medium distinct reddish gray (5YR 5/2) and few fine prominent yellowish red (5YR 4/8) mottles; moderate medium platy structure; firm; few fine faint patchy reddish brown (2.5YR 4/4) clay films on faces of peds; about 14 percent gravel; moderately acid; clear wavy boundary.
Cd—45 to 60 inches; dark reddish brown (5YR 3/4) gravelly sandy loam; massive, moderate medium platy soil fragments; firm; about 15 percent gravel; moderately acid.

The thickness of the solum ranges from 40 to 50 inches. Depth to the firm till ranges from 20 to 40 inches. The content of gravel ranges from 1 to 15 percent in the upper part of the profile and from 5 to 20 percent in the lower part.

The A or Ap horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loam, but the range includes fine sandy loam, sandy loam, very fine sandy loam, and silt loam. The content of stones ranges from 0 to 10 percent.

The E horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 1 or 2. It is loam, fine sandy loam, sandy loam, or very fine sandy loam.

The BE and Bt horizons have hue of 10YR, 7.5YR, or 5YR and chroma of 2 to 4. They are sandy loam, fine sandy loam, or loam.

The BC horizon has hue of 5YR or 2.5YR, value of 3 or 4, and chroma of 2 to 4. It is loam, sandy loam, or fine sandy loam.

The Cd horizon has hue of 2.5YR or 5YR and value and chroma of 3 or 4. It is sandy loam, fine sandy loam, or the gravelly analogs of those textures.

Rosholt Series

The Rosholt series consists of well drained soils on outwash plains. These soils formed in loamy deposits and in the underlying sand and gravel. Permeability is moderate or moderately rapid in the upper part of the profile and rapid or very rapid in the lower part. Slopes range from 1 to 4 percent.

The Rosholt soils in this county have a base saturation in the Bt horizon that is higher than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Rosholt silt loam, 1 to 4 percent slopes, 700 feet east and 15 feet north of the southwest corner of sec. 9, T. 40 N., R. 28 W.

Ap—0 to 10 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate medium granular structure; friable; common medium roots; about 1 percent gravel; slightly acid; abrupt smooth boundary.
E/B—10 to 16 inches; brown (10YR 5/3) silt loam (E) and brown (7.5YR 5/4) loam (Bt); weak fine subangular blocky structure; friable; common medium roots; about 1 percent gravel; moderately acid; clear wavy boundary.
Bt1—16 to 23 inches; brown (7.5YR 4/4) loam; moderate medium subangular blocky structure; friable; common fine roots; few fine faint reddish brown (5YR 4/4) clay films on faces of peds; about 3 percent gravel; moderately acid; clear wavy boundary.
2Bt2—23 to 26 inches; brown (7.5YR 5/4) sandy loam; moderate medium subangular blocky structure; friable; few very fine roots; few fine faint dark brown (7.5YR 4/4) clay films on faces of peds; about 5 percent gravel; slightly acid; clear wavy boundary.
2C—26 to 60 inches; brown (7.5YR 4/4) very gravelly coarse sand; loose; few very fine roots; about 55 percent gravel; slightly acid.

The thickness of the solum ranges from 20 to 40 inches. The content of gravel ranges from 0 to 20 percent in the upper part of the profile and from 0 to 40 percent in the lower part of the solum. The content of gravel in the 2C horizon ranges from 0 to 70 percent.

The Ap or A horizon has value of 3 or 4 and chroma of 2 or 3. It is dominantly silt loam, but the range includes loam, sandy loam, fine sandy loam, and the gravelly analogs of those textures.

The E horizon, if it occurs, has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 or 3. It is silt loam, sandy loam, fine sandy loam, loamy sand, loam, or the gravelly analogs of those textures.

The Bt horizon has hue of 10YR, 5YR, or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is loam, sandy loam, or the gravelly or very gravelly analogs of those textures.

The 2Bt horizon has hue of 10YR, 7.5YR, or 5YR and value and chroma of 3 to 6. It is fine sandy loam, sandy loam, loamy sand, sand, or the gravelly, very gravelly, or extremely gravelly analogs of those textures.

The 2C horizon has hue of 10YR, 7.5YR, or 5YR and value and chroma of 3 to 6. It is coarse sand, sand, loamy sand, or the gravelly or very gravelly analogs of those textures. It is commonly stratified.

Sartell Series

The Sartell series consists of excessively drained, rapidly permeable soils on outwash plains and valley trains. These soils formed in sandy eolian or outwash sediments. Slopes range from 1 to 12 percent.

Typical pedon of Sartell loamy fine sand, 1 to 6 percent slopes, 500 feet east and 50 feet south of the northwest corner of sec. 12, T. 39 N., R. 32 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; very friable; many medium roots; strongly acid; abrupt smooth boundary.

BA—7 to 13 inches; brown (10YR 4/3) fine sand; single grain; loose; few fine roots; moderately acid; gradual wavy boundary.

Bw1—13 to 25 inches; dark yellowish brown (10YR 4/4) fine sand; single grain; loose; few fine roots; moderately acid; gradual wavy boundary.

Bw2—25 to 39 inches; brown (10YR 5/3) fine sand; single grain; loose; moderately acid; gradual wavy boundary.

C—39 to 60 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; moderately acid.

The thickness of the solum ranges from 24 to 40 inches.

The Ap or A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loamy fine sand, but the range includes fine sand, sand, and loamy sand.

The BA and Bw horizons have value and chroma of 3 to 5. They are fine sand or sand.

The C horizon has value of 5 to 7 and chroma of 2 to 6.

Seelyeville Series

The Seelyeville series consists of very poorly drained soils on outwash plains, valley trains, and moraines. These soils formed in highly decomposed organic material. Permeability is moderately rapid to moderately slow. Slopes range from 0 to 2 percent.

Typical pedon of Seelyeville muck, 200 feet west and 20 feet south of the northeast corner of sec. 27, T. 127 N., R. 31 W.

Oa1—0 to 12 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 10 percent fiber unrubbed, 5 percent rubbed; weak fine granular structure; primarily herbaceous fibers; moderately acid; clear wavy boundary.

Oa2—12 to 44 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 25 percent fiber unrubbed, 8 percent rubbed; massive; primarily herbaceous fibers; moderately acid; clear wavy boundary.

Oa3—44 to 60 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 15 percent fiber unrubbed, 5 percent rubbed; massive; primarily herbaceous fibers; moderately acid.

The organic material is more than 51 inches thick. Reaction ranges from strongly acid to mildly alkaline.

The sapric material has hue of 10YR or 7.5YR and value of 2 or 3. The content of fiber is less than 25 percent before rubbing and less than 10 percent after rubbing.

Soderville Series

The Soderville series consists of somewhat poorly drained, rapidly permeable soils on outwash plains. These soils formed in sandy eolian or outwash sediments or both. Slopes range from 0 to 2 percent.

The Soderville soils in this county are outside the range defined for the series because the part of the argillic horizon within a depth of 40 inches is fine sandy loam and is consequently coarse-loamy. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Soderville loamy fine sand, 1,500 feet north and 50 feet east of the southwest corner of sec. 24, T. 132 N., R. 31 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many medium roots; strongly acid; abrupt smooth boundary.

E—8 to 31 inches; brown (10YR 5/3) loamy fine sand, light brownish gray (10YR 6/2) dry; few fine distinct yellowish brown (10YR 5/6), strong brown (7.5YR 5/6), and light brownish gray (10YR 6/2) mottles; weak thin platy structure; very friable; few fine roots; strongly acid; clear wavy boundary.

Bt1—31 to 39 inches; brown (10YR 5/3) fine sandy loam; few fine prominent brownish yellow (10YR 6/8), many medium prominent yellowish brown (10YR 5/6), and few fine faint light brownish gray (10YR 6/2) mottles; weak fine subangular blocky structure; very friable; few fine roots; colloid in bridges between mineral grains; strongly acid; clear wavy boundary.

Bt2—39 to 49 inches; brown (10YR 5/3) loamy fine sand; common medium prominent brownish yellow (10YR 6/8), few fine faint light brownish gray (10YR 6/2), and many fine prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; very friable; few fine roots; colloid in bridges between mineral grains; moderately acid; clear wavy boundary.

C—49 to 60 inches; pale brown (10YR 6/3) fine sand; few fine prominent brownish yellow (10YR 6/8) mottles; single grain; loose; moderately acid.

The thickness of the solum ranges from 36 to 60 inches. Depth to the Bt horizon is 15 to 50 inches.

The Ap or A horizon has value of 3 or 4 and chroma of 1 or 2. The upper part of the A horizon in undisturbed pedons has hue of 10YR, value of 2 or 3, and chroma of 1. This horizon is loamy fine sand, but the range includes fine sand.

The E horizon has value of 4 or 5 and chroma of 2 or 3. It is loamy fine sand or fine sand.

The Bt horizon has hue of 7.5YR or 10YR, value of 4 to 7, and chroma of 3 or 4. It is loamy fine sand, fine sand that has a high content of clay, or fine sandy loam.

The C horizon has hue of 10YR or 7.5YR, value of 4 to 7, and chroma of 3 to 5. It is fine sand or sand.

Warman Series

The Warman series consists of very poorly drained soils on outwash plains. These soils formed in a loamy mantle over sandy deposits. Permeability is moderate or moderately rapid in the upper part of the profile and rapid or very rapid in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Warman loam, 1,500 feet west and 300 feet north of the southeast corner of sec. 8, T. 40 N., R. 28 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; friable; common medium roots; about 2 percent gravel; moderately acid; abrupt smooth boundary.

AB—9 to 12 inches; very dark grayish brown (10YR 3/2) very fine sandy loam, grayish brown (10YR 5/2) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; friable; common medium roots; about 2 percent gravel; moderately acid; clear wavy boundary.

Bg1—12 to 20 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; friable; common medium roots; about 3 percent gravel; moderately acid; clear wavy boundary.

Bg2—20 to 26 inches; grayish brown (10YR 5/2) fine sandy loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; friable; common fine roots; about 5 percent gravel; slightly acid; clear wavy boundary.

Bg3—26 to 33 inches; grayish brown (10YR 5/2) loam; common medium distinct dark yellowish brown (10YR 4/4) and common medium faint light brownish gray (10YR 6/2) mottles; moderate medium subangular blocky structure; friable; few fine roots; about 3 percent gravel; slightly acid; clear wavy boundary.

2C—33 to 60 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; few very fine roots; about 10 percent gravel; slightly acid.

The thickness of the solum ranges from 20 to 40 inches. The content of gravel ranges from 0 to 15 percent in the upper part of the profile and from 5 to 55 percent in the lower part. The mollic epipedon is 7 to 24 inches thick.

The Ap and AB horizons have value of 2 or 3 and chroma of 0 to 2. They are dominantly loam, but the range includes silt loam, very fine sandy loam, fine sandy loam, loamy fine sand, and the mucky analogs of those textures.

The upper part of the B horizon has hue of 10YR or

2.5Y, value of 3 to 5, and chroma of 1 or 2. The lower part has hue of 5YR, 7.5YR, or 10YR, value of 4 to 6, and chroma of 1 to 4. This horizon is loam, very fine sandy loam, fine sandy loam, silt loam, or sandy loam.

The 2C horizon has hue of 5YR, 10YR, or 7.5YR, value of 3 to 6, and chroma of 2 to 4. It is sand, coarse sand, or the gravelly analogs of those textures.

Warman Variant

The Warman Variant consists of very poorly drained soils on outwash plains. These soils formed in clayey glacial lacustrine sediments. Permeability is moderately slow or slow. Slopes range from 0 to 2 percent.

Typical pedon of Warman Variant silty clay loam, 2,175 feet north and 1,025 feet east of the southwest corner of sec. 23, T. 129 N., R. 30 W.

A1—0 to 10 inches; black (10YR 2/1) silty clay loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; many fine roots; neutral; clear wavy boundary.

A2—10 to 14 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 6/1) dry; weak medium subangular blocky structure; friable; few fine roots; neutral; clear wavy boundary.

Bg—14 to 31 inches; light brownish gray (2.5Y 6/2) silty clay loam; many fine prominent brownish yellow (10YR 6/8) mottles; weak medium subangular blocky structure; friable; few fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

Cg—31 to 60 inches; light gray (5Y 7/2) silty clay; many medium prominent brownish yellow (10YR 6/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 10 to 40 inches. The content of gravel ranges from 0 to 5 percent. The mollic epipedon is 10 to 18 inches thick. The depth to free carbonates ranges from 10 to 20 inches.

The A horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 1 or less.

The Bg horizon, if it occurs, has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is dominantly silty clay loam, clay, silty clay, or clay loam.

The Cg horizon has hue of 2.5Y or 5Y, value of 5 to 7, and chroma of 1 or 2. It is silty clay loam, silty clay, loam, or clay loam.

Watab Series

The Watab series consists of somewhat poorly drained soils on drumlins and ground moraines. These soils formed in a mantle of eolian or lacustrine sediments and underlying dense till. Permeability is rapid in the upper part of the profile and slow or very slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Watab loamy fine sand, 1,300 feet south and 90 feet east of the northwest corner of sec. 30, T. 39 N., R. 30 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; many medium roots; moderately acid; abrupt smooth boundary.

E—8 to 11 inches; dark grayish brown (10YR 4/2) loamy fine sand; few fine faint dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; very friable; common medium roots; strongly acid; clear wavy boundary.

EB—11 to 26 inches; dark brown (10YR 4/3) loamy fine sand; few fine faint dark yellowish brown (10YR 4/4) and grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; very friable; few fine roots; strongly acid; clear wavy boundary.

Bw—26 to 30 inches; yellowish brown (10YR 5/6) loamy fine sand; common medium distinct light brownish gray (10YR 6/2) mottles; weak medium subangular blocky structure; very friable; few fine roots; strongly acid; clear wavy boundary.

2Bt—30 to 39 inches; brown (7.5YR 5/4) fine sandy loam; many medium prominent light brownish gray (10YR 6/2) mottles; weak medium platy structure; very friable; few very fine roots; about 10 percent gravel; few fine faint reddish brown clay films on faces of peds; moderately acid; clear wavy boundary.

2BC—39 to 51 inches; brown (7.5YR 4/4) sandy loam; few medium distinct reddish brown (5YR 5/3) mottles; weak medium platy structure; firm; about 12 percent gravel; moderately acid; clear wavy boundary.

2Cd—51 to 60 inches; brown (7.5YR 4/4) sandy loam; massive, moderate medium platy soil fragments; firm; about 10 percent gravel; moderately acid.

The thickness of the solum ranges from 40 to 55 inches. Depth to the till ranges from 25 to 40 inches. The content of gravel is 0 to 2 percent in the A, E, and Bw horizons and is 8 to 20 percent in the 2B and 2Cd horizons.

The Ap or A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loamy fine sand, but the range includes loamy sand, fine sand, and sand.

The E horizon has value of 4 or 5 and chroma of 2 or 3. It is loamy fine sand, loamy sand, fine sand, or sand.

The Bw horizon has value of 4 or 5 and chroma of 3 to 6. It is loamy fine sand or loamy sand.

The 2Bt horizon has hue of 7.5YR or 5YR and chroma of 3 or 4. It is sandy loam, fine sandy loam, or the gravelly analogs of those textures.

The 2BC and 2Cd horizons have hue of 7.5YR or 5YR and chroma of 3 or 4. They are sandy loam, fine sandy loam, or the gravelly analogs of those textures.

Winterfield Series

The Winterfield series consists of somewhat poorly drained, rapidly permeable soils on flood plains. These soils formed in sandy alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Winterfield loamy sand, in an area of Fordum-Winterfield complex, 1,800 feet east and 700 feet north of the southwest corner of sec. 1, T. 39 N., R. 32 W.

A—0 to 4 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; moderate medium granular structure; very friable; many medium roots; slightly acid; abrupt smooth boundary.

C1—4 to 29 inches; very dark brown (10YR 2/2), stratified loamy sand and loamy fine sand, grayish brown (10YR 5/2) dry; moderate medium granular structure; very friable; few fine roots; moderately acid; clear wavy boundary.

C2—29 to 40 inches; dark grayish brown (10YR 4/2) sand; common medium faint grayish brown (10YR 5/2) and few fine distinct yellowish brown (10YR 5/4) mottles; single grain; loose; about 5 percent gravel; moderately acid; clear wavy boundary.

C3—40 to 60 inches; dark grayish brown (10YR 4/2) sand; few fine distinct light brownish gray (10YR 6/2) mottles; single grain; loose; about 14 percent gravel; moderately acid.

The control section varies in texture within short ranges in depth.

The A horizon has hue of 7.5YR or 10YR, value of 2 to 4, and chroma of 1 to 3. It is dominantly loamy sand, but the range includes loamy fine sand, fine sand, sand, very fine sandy loam, fine sandy loam, and sandy loam.

The C horizon has hue of 5YR to 10YR and value and chroma of 2 to 6. It is loamy sand, sand, loamy fine sand, gravelly sand, or gravelly loamy sand.

Zimmerman Series

The Zimmerman series consists of excessively drained, rapidly permeable soils on outwash plains and valley trains. These soils formed in sandy outwash and eolian sediments. Slopes range from 1 to 4 percent.

Typical pedon of Zimmerman loamy fine sand, 1 to 4 percent slopes, 1,700 feet west and 1,200 feet north of the southeast corner of sec. 4, T. 132 N., R. 30 W.

Ap—0 to 6 inches; black (10YR 2/1) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

E1—6 to 10 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; weak fine subangular blocky structure; very friable; many medium roots; strongly acid; gradual wavy boundary.

E2—10 to 19 inches; brown (10YR 5/3) fine sand, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; very friable; many medium roots; strongly acid; clear wavy boundary.

Bw—19 to 32 inches; dark brown (10YR 4/3) fine sand; single grain; loose; many fine roots; moderately acid; gradual wavy boundary.

E′—32 to 38 inches; dark yellowish brown (10YR 4/4) loamy fine sand; single grain; loose; few fine roots; moderately acid; abrupt irregular boundary.

E&Bt—38 to 60 inches; yellowish brown (10YR 5/4) fine sand (E); single grain; loose; few, irregular and discontinuous, very weakly cemented pale brown (10YR 6/3) bands of loamy fine sand or fine sandy loam ¼ to ½ inch thick (Bt); moderately acid.

The thickness of the solum ranges from 40 to 80 inches.

The Ap or A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loamy fine sand, but the range includes fine sand. The E and E′ horizons have value of 4 to 7 and chroma of 2 to 4.

The Bw horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6.

The E&Bt horizon consists of one or more thin, irregular, discontinuous or continuous lamellae or bands. It has hue of 5YR, 7.5YR, or 10YR, value of 3 to 5, and chroma of 2 to 6. It is loamy fine sand, but the range includes fine sand, very fine sand, and fine sandy loam. Some pedons have a C horizon.

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Formation of the Soils

Soil is a natural, three-dimensional body on the earth's surface that is capable of supporting the growth of plants. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the relief, or lay of the land; the length of time the forces of soil formation have acted on the soil material; the climate under which the soil material has accumulated and weathered; and the plant and animal life on and in the soil.

Climate and plant and animal life, chiefly plants, are the active factors of soil formation. They act on the parent material that has accumulated and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed. Finally, time is needed for the transformation of the parent material into soil. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent Material

The soils of Morrison County formed in the glacial drift and the modified glacial drift of the late Wisconsin glaciation. The last advances of the ice, the Riny and Superior Lobe advances, buried and rearranged early ice advances *(3)*. The Wadena Lobe drift is an early ice advance from the northwest. This glacier deposited gray drift, which is high in calcium carbonate. In the southwest part of the county, this drift is covered by a thin brown layer of glacial drift. Growton and Holdingford soils are typical soils in this area. In a few areas glacial meltwater rushing over the surface scoured away the drift and exposed bedrock. Interdrumlin areas had enough meltwater runoff to concentrate large stones at the surface by removing the finer, more erodible material. This stone pavement, or boulder pavement, is common in the drumlinized part of the county. Another characteristic of parent material common to drumlinized topography is the dense platy till, which was probably created by the intense weight and pressure of the advancing ice *(4)*.

Three major drumlin fields, including the Brainerd and Pierz drumlin fields, are located in the county. The long axes of the drumlin ridges on the Brainerd drumlin field are oriented in a northeast to southwest direction. This field is in areas of more stony, sandy loam glacial till. The drumlins are not well defined. The Brainerd drumlin field is centered in Platte Township. The drumlin axes of the Pierz drumlin field are oriented in a southeast to northwest direction. This field is in areas of sandy loam glacial till. The drumlins are well defined. The Pierz drumlin field is centered in Buckman Township. The third field is probably a subdued extension of the Pierz field. Its orientation and material are similar to those of the Pierz field. The proportion of somewhat poorly drained soils is higher in this area because of the gentle slopes. This third field is west of the Mississippi River, centered in Culdrum Township.

As the various ice advances receded from the county, meltwater deposited sand and gravel, particularly in the Scandia Valley. Various strata of finer textured material occur on the flat plains, near the valley. The texturally banded Zimmerman and Soderville soils are examples of soils in these areas. Menahga and Mahtomedi soils are in areas of very steep outwash, north and east of the Scandia Valley and southeast of Little Falls. Mahtomedi and Emmert are typical soils in the many areas of eskers that are associated with outwash. An extensive sand plain is in the central portion of the county. The major natural drainageways cross this plain. Hubbard, Fordum, and Winterfield soils are common in these areas. Undrained depressions in the till landscape of the eastern part of the county eventually filled in with organic material. Seelyeville soils formed in these areas.

Relief

Relief influences the formation of soils through its effects on drainage, runoff, and erosion. These effects are modified on drumlins, where the dense subsoil

restricts drainage. As a result, some areas on slopes consist of moderately well drained and somewhat poorly drained soils. Maximum profile development takes place in well drained, level to gently sloping soils. Cushing and Holdingford soils are examples. Profile development is slower on steep slopes because the runoff is rapid and less water is available for plant growth and for leaching. Emmert soils are an example. The excess surface water that collects in depressions or ground water that surfaces in depressions also affects soil formation. Prebish and Isan soils in depressions are naturally wet soils.

Time

Soils develop with time. The time required for soil formation is modified by the other factors of soil formation. Depending on the other soil-forming factors, the effects of time can be accelerated or repressed. The soils in Morrison County are relatively young. The process of soil formation began about 10,000 years ago when the ice receded and glacial streams became active. The most immature soils in the county are along the rivers or creeks that frequently flood. In these areas, the soil-forming factors have not had long to work and the continuing deposition of flood plain sediments retards the soil-forming processes.

Climate

Climate directly influences soil formation through the effects of temperature and precipitation. Temperature influences the rate of physical and chemical reactions in the soil and the level of biological activity. Freezing in winter slows the soil-forming processes. Alternate freezing and thawing hasten weathering and mix the soil. Water supports biological activity, dissolves minerals, and transports minerals and organic matter throughout the soil profile. The amount of water moving through the profile depends on the amount of precipitation, the landscape position, the permeability of the soil, and other factors of soil formation.

Morrison County has a modified continental climate that is characterized by cold winters and hot summers. The climate and other factors have created a transitional area within the county. This area includes the prairie grassland of the southwest that is mixed with hardwood forest and the coniferous woodland of the northeast.

The climate is essentially uniform throughout the county. Variations in microclimate are caused by differences in relief, soil material, direction of slope, and vegetation. South- and west-facing slopes tend to be drier and warmer than north- and east-facing slopes. More information about the climate of Morrison County is given in the section "General Nature of the County."

Plant and Animal Life

The processes of soil formation started in the county when plants began to grow in the unconsolidated material left by glacial activity. Plant roots loosen the earth material and transport minerals up from the parent material. The plants die and decay and thus return organic matter and plant nutrients to the soil. Bacteria, fungi, and other micro-organisms help to decompose the vegetative matter and contribute to soil structure. Earthworms and burrowing animals mix the soil material from different horizons and carry the parent material to the surface.

According to the original map of vegetation in Minnesota, the typical native vegetation in this county consisted of hardwood forest on the western and southern edges of the county and prairie grasslands on the sand plains along the Mississippi River. The steeper edges of the sand plains were covered with scattered bur oak. The northern and eastern sides of the county were mostly pine forest interspersed with scattered bogs and swamps.

The nutrient cycling that is common to grasslands produced the deep, dark surface layer characteristic of prairie soils. These soils are more common in the southwestern half of the county. The nutrient cycling that is dominant in areas of pine trees and hardwoods in the northern portion of the county produced a much thinner dark surface layer.

Humans influence soil formation through activities that alter drainage and the water table and through tillage, which mixes the soil to varying degrees. Various other management practices change the vegetation and, in many cases, accelerate erosion.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding system. A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on the contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

California bearing ratio (CBR). The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent

material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per

cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow

is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, or clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Graded stripcropping. Growing crops in strips that grade toward a protected waterway.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is

allowed to flow onto an area without controlled distribution.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by the wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the

saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plinthite. The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saprolite (soil science). Unconsolidated residual

material underlying the soil and grading to hard bedrock below.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Sloughed till. Water-saturated till that has flowed slowly downhill from its original place of deposit by glacial ice. It may rest on other till, on glacial outwash, or on a glaciolacustrine deposit.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant

and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive area of nearly level to undulating soils underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limitec geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer of a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-81 at Little Falls, Minnesota)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	18.5	-3.8	7.4	44	-34	0	0.70	0.15	1.12	2	9.5
February----	26.1	1.9	14.0	47	-29	0	.66	.10	1.09	2	7.7
March-------	37.6	14.8	26.2	63	-23	10	1.23	.46	1.86	4	9.2
April-------	55.6	31.2	43.4	84	9	42	2.10	.96	3.07	5	1.6
May---------	69.9	43.1	56.5	90	23	242	2.97	1.65	4.13	7	.1
June--------	78.1	53.3	65.7	94	36	471	4.34	2.71	5.81	8	.0
July--------	83.1	58.1	70.6	96	43	639	3.91	2.06	5.51	7	.0
August------	80.7	55.8	68.3	95	39	567	4.07	1.79	6.01	7	.0
September---	70.6	46.2	58.4	91	25	261	2.29	1.06	3.34	5	.0
October-----	59.3	35.9	47.6	82	15	90	2.04	.45	3.29	4	.4
November----	40.0	21.8	30.9	66	-10	0	1.17	.36	1.83	3	4.2
December----	25.0	5.8	15.4	47	-28	0	.73	.20	1.15	3	8.4
Yearly:											
Average---	53.7	30.7	42.0	---	---	---	---	---	---	---	---
Extreme---	---	---	---	98	-36	---	---	---	---	---	---
Total-----	---	---	---	---	---	2,322	26.21	21.07	30.79	57	41.1

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-81 at Little Falls, Minnesota)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 9	May 18	May 26
2 years in 10 later than--	May 3	May 13	May 22
5 years in 10 later than--	Apr. 23	May 3	May 14
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 1	Sept. 16	Sept. 12
2 years in 10 earlier than--	Oct. 7	Sept. 21	Sept. 16
5 years in 10 earlier than--	Oct. 17	Oct. 1	Sept. 23

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-81 at Little Falls, Minnesota)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	153	127	114
8 years in 10	161	135	120
5 years in 10	176	150	131
2 years in 10	191	165	143
1 year in 10	199	173	149

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
7A	Hubbard loamy sand, 0 to 2 percent slopes	8,725	1.2
7B	Hubbard loamy sand, 2 to 6 percent slopes	8,155	1.1
12C	Emmert gravelly loamy sand, 6 to 12 percent slopes	210	*
12D	Emmert gravelly loamy sand, 12 to 40 percent slopes	410	0.1
25	Becker fine sandy loam	800	0.1
119B	Pomroy loamy fine sand, 1 to 6 percent slopes	27,630	3.7
119C	Pomroy loamy fine sand, 6 to 12 percent slopes	2,180	0.3
142	Nokay loam	56,880	7.6
144B	Flak sandy loam, 4 to 8 percent slopes	21,170	2.8
144C	Flak sandy loam, 8 to 15 percent slopes	8,725	1.2
144E	Flak sandy loam, 15 to 25 percent slopes	2,200	0.3
152B	Milaca fine sandy loam, 4 to 8 percent slopes	3,640	0.5
152C	Milaca fine sandy loam, 8 to 15 percent slopes	730	0.1
155B	Chetek sandy loam, 2 to 8 percent slopes	6,830	0.9
155C	Chetek sandy loam, 8 to 15 percent slopes	720	0.1
158B	Zimmerman loamy fine sand, 1 to 4 percent slopes	4,360	0.6
161	Isanti fine sandy loam	2,900	0.4
163B	Brainerd sandy loam, 1 to 4 percent slopes	101,430	13.6
164B	Mora fine sandy loam, 1 to 4 percent slopes	13,810	1.9
165	Parent loam	30,100	4.1
166	Ronneby loam	9,820	1.3
182A	Oesterle sandy loam, 0 to 1 percent slopes	5,575	0.8
182B	Oesterle sandy loam, 1 to 3 percent slopes	1,890	0.3
200B	Holdingford sandy loam, 4 to 8 percent slopes	9,160	1.2
200C	Holdingford sandy loam, 8 to 15 percent slopes	4,000	0.5
202	Meehan loamy sand	9,450	1.3
204B	Cushing fine sandy loam, 4 to 8 percent slopes	10,900	1.5
204C	Cushing fine sandy loam, 8 to 15 percent slopes	2,560	0.3
204E	Cushing fine sandy loam, 15 to 25 percent slopes	760	0.1
217	Nokasippi mucky loamy fine sand	4,370	0.6
218	Watab loamy fine sand	10,900	1.5
233A	Growton sandy loam, 0 to 2 percent slopes	4,360	0.6
233B	Growton sandy loam, 2 to 4 percent slopes	22,540	3.0
260	Duelm loamy sand	10,180	1.4
261	Isan sandy loam	10,900	1.5
264B	Freeon silt loam, 1 to 4 percent slopes	4,770	0.6
265	Soderville loamy fine sand	1,450	0.2
266	Freer silt loam	7,270	1.0
292	Alstad loam	3,200	0.4
302B	Rosholt silt loam, 1 to 4 percent slopes	1,550	0.2
325	Prebish loam	27,950	3.8
328B	Sartell loamy fine sand, 1 to 6 percent slopes	4,070	0.5
328C	Sartell loamy fine sand, 6 to 12 percent slopes	225	*
337	Warman loam	3,650	0.5
341A	Arvilla sandy loam, 0 to 2 percent slopes	2,550	0.3
341B	Arvilla sandy loam, 2 to 6 percent slopes	1,975	0.3
375	Forada loam	3,570	0.5
413	Osakis loam	750	0.1
454B	Mahtomedi loamy sand, 2 to 8 percent slopes	13,200	1.8
454C	Mahtomedi loamy sand, 8 to 15 percent slopes	9,450	1.3
454E	Mahtomedi loamy sand, 15 to 25 percent slopes	6,100	0.8
454F	Mahtomedi loamy sand, 25 to 45 percent slopes	3,200	0.4
458A	Menahga loamy sand, 0 to 2 percent slopes	6,100	0.8
458B	Menahga loamy sand, 2 to 8 percent slopes	13,180	1.8
458C	Menahga loamy sand, 8 to 15 percent slopes	9,450	1.3
458E	Menahga loamy sand, 15 to 25 percent slopes	2,180	0.3
458F	Menahga loamy sand, 25 to 45 percent slopes	1,450	0.2
540	Seelyeville muck	28,550	3.9
541	Rifle muck	16,720	2.3
543	Markey muck	13,800	1.9
544	Cathro muck	35,625	4.8
549	Greenwood peat	15,270	2.1

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
623A	Pierz sandy loam, 0 to 2 percent slopes	5,810	0.8
623B	Pierz sandy loam, 2 to 6 percent slopes	6,550	0.9
835	Brainerd-Rock outcrop complex	150	*
928B	Cushing-Mahtomedi-DeMontreville complex, 2 to 8 percent slopes	9,900	1.3
928C	Cushing-Mahtomedi-DeMontreville complex, 8 to 15 percent slopes	8,290	1.1
928E	Cushing-Mahtomedi-DeMontreville complex, 15 to 25 percent slopes	4,650	0.6
928F	Cushing-Mahtomedi-DeMontreville complex, 25 to 45 percent slopes	1,890	0.3
1015	Psamments, nearly level	1,420	0.2
1016	Udorthents, loamy	285	*
1030	Pits, gravel-Udorthents complex	730	0.1
1934	Bowstring muck	3,640	0.5
1946	Fordum-Winterfield complex	9,450	1.3
1973	Meehan-Isan complex	5,820	0.8
1976B	Brainerd sandy loam, 1 to 4 percent slopes, extremely stony	2,180	0.3
1977B	Mora fine sandy loam, 1 to 4 percent slopes, extremely stony	380	0.1
1978	Nokay loam, extremely stony	2,900	0.4
1979	Parent loam, extremely stony	370	*
1980	Ronneby loam, extremely stony	390	0.1
1998	Warman Variant silty clay loam	250	*
	Water	19,200	2.6
	Total	740,480	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
25	Becker fine sandy loam
142	Nokay loam (where drained)
144B	Flak sandy loam, 4 to 8 percent slopes
152B	Milaca fine sandy loam, 4 to 8 percent slopes
163B	Brainerd sandy loam, 1 to 4 percent slopes
164B	Mora fine sandy loam, 1 to 4 percent slopes
166	Ronneby loam (where drained)
182A	Oesterle sandy loam, 0 to 1 percent slopes
182B	Oesterle sandy loam, 1 to 3 percent slopes
200B	Holdingford sandy loam, 4 to 8 percent slopes
204B	Cushing fine sandy loam, 4 to 8 percent slopes
233A	Growton sandy loam, 0 to 2 percent slopes
233B	Growton sandy loam, 2 to 4 percent slopes
264B	Freeon silt loam, 1 to 4 percent slopes
266	Freer silt loam
292	Alstad loam (where drained)
302B	Rosholt silt loam, 1 to 4 percent slopes
623A	Pierz sandy loam, 0 to 2 percent slopes
623B	Pierz sandy loam, 2 to 6 percent slopes

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Oats	Corn	Corn silage	Bromegrass-alfalfa hay	Kentucky bluegrass	Bromegrass alfalfa
		Bu	Bu	Tons	Tons	AUM*	AUM*
7A---------- Hubbard	IVs	55	60	8	2.2	2.0	---
7B---------- Hubbard	IVs	50	55	7	2.2	2.0	---
12C---------- Emmert	IVs	18	40	6	2.2	1.2	3.2
12D---------- Emmert	VIIs	---	---	---	---	---	---
25---------- Becker	IIs	70	90	8	4.2	---	6.4
119B---------- Pomroy	IIIs	60	75	11	---	2.0	4.5
119C---------- Pomroy	IVs	55	70	10	---	1.5	3.7
142---------- Nokay	IIw	75	85	13	---	3.0	---
144B, 144C------ Flak	IIIe	55	65	9	3.2	3.0	4.7
144E---------- Flak	VIe	---	---	---	---	2.0	3.7
152B, 152C------ Milaca	IIIe	75	80	11	3.8	3.0	5.5
155B---------- Chetek	IIIe	60	55	11	3.0	1.8	---
155C---------- Chetek	IVe	55	45	10	2.5	1.4	---
158B---------- Zimmerman	IVs	50	60	10	1.7	2.2	3.3
161---------- Isanti	Vw	---	---	---	---	---	---
163B---------- Brainerd	IIe	70	90	13	---	3.0	6.5
164B---------- Mora	IIe	75	95	16	4.8	3.0	6.9
165---------- Parent	IIIw	50	60	9	---	4.0	---
166---------- Ronneby	IIw	70	80	14	---	3.5	---

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Oats	Corn	Corn silage	Bromegrass-alfalfa hay	Kentucky bluegrass	Bromegrass alfalfa
		Bu	Bu	Tons	Tons	AUM*	AUM*
182A---------- Oesterle	IIw	70	75	12	4.0	3.5	---
182B---------- Oesterle	IIe	70	75	12	4.0	3.5	---
200B, 200C------ Holdingford	IIIe	65	90	14	---	3.0	6.0
202---------- Meehan	IVw	50	50	8	2.5	1.3	---
204B, 204C------ Cushing	IIIe	75	90	15	5.0	4.3	---
204E---------- Cushing	VIe	---	---	---	4.0	3.0	---
217---------- Nokasippi	VIw	---	---	---	---	---	---
218---------- Watab	IIIw	55	80	10	---	2.0	3.8
233A---------- Growton	IIw	75	100	12	---	3.0	5.2
233B---------- Growton	IIe	70	95	12	---	3.0	5.2
260---------- Duelm	IVs	55	65	10	---	---	---
261---------- Isan	Vw	---	---	---	---	---	---
264B---------- Freeon	IIe	80	100	12	4.5	3.3	---
265---------- Soderville	IVw	50	65	6	---	3.5	4.9
266---------- Freer	IIw	65	90	13	3.4	3.0	5.0
292---------- Alstad	IIe	75	105	14	4.5	3.6	---
302B---------- Rosholt	IIe	70	70	13	4.0	3.8	---
325---------- Prebish	VIw	---	---	---	---	---	---
328B---------- Sartell	IVs	45	55	4	1.8	1.5	3.0
328C---------- Sartell	VIs	---	---	---	1.6	1.3	2.7

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Oats	Corn	Corn silage	Bromegrass-alfalfa hay	Kentucky bluegrass	Bromegrass alfalfa
		Bu	Bu	Tons	Tons	AUM*	AUM*
337--Warman	VIw	---	---	---	---	---	---
341A--Arvilla	IIIs	45	65	9	2.5	---	---
341B--Arvilla	IIIe	40	55	8	2.0	---	---
375--Forada	IIw	80	85	13	---	---	---
413--Osakis	IIIs	65	65	10	2.8	2.0	---
454B, 454C--Mahtomedi	IVs	30	30	5	2.2	1.2	3.3
454E--Mahtomedi	VIs	---	---	---	---	1.0	---
454F--Mahtomedi	VIIs	---	---	---	---	0.8	---
458A, 458B, 458C--Menahga	IVs	45	50	6	2.3	1.2	3.6
458E--Menahga	VIs	---	---	---	---	0.7	---
458F--Menahga	VIIs	---	---	---	---	0.7	---
540--Seelyeville	VIw	---	---	---	---	---	---
541--Rifle	VIw	---	---	---	---	---	---
543--Markey	VIw	---	---	---	---	---	---
544--Cathro	VIw	---	---	---	---	---	---
549--Greenwood	VIw	---	---	---	---	---	---
623A--Pierz	IIs	75	80	13	3.5	3.0	---
623B--Pierz	IIe	70	75	12	3.0	3.0	---
835**--Brainerd-Rock outcrop.	IIe	---	---	---	---	---	---

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Oats	Corn	Corn silage	Bromegrass-alfalfa hay	Kentucky bluegrass	Bromegrass alfalfa
		Bu	Bu	Tons	Tons	AUM*	AUM*
928B**----------		64	---	12	---	2.8	---
Cushing--------	IIe						
Mahtomedi------	IVs						
DeMontreville--	IIIs						
928C**----------		59	---	10	---	2.6	---
Cushing--------	IIIe						
Mahtomedi------	IVs						
DeMontreville--	IVe						
928E**----------		---	---	---	---	1.8	---
Cushing--------	VIe						
Mahtomedi------	VIs						
DeMontreville--	VIe						
928F**----------		---	---	---	---	1.7	---
Cushing--------	VIe						
Mahtomedi------	VIIs						
DeMontreville--	VIIe						
1015. Psamments							
1016. Udorthents							
1030**. Pits-Udorthents							
1934---------- Bowstring	VIw	---	---	---	---	---	---
1946**---------- Fordum-Winterfield	VIw	---	---	---	---	---	---
1973**----------		---	---	---	---	---	---
Meehan---------	IVw						
Isan-----------	Vw						
1976B----------- Brainerd	VIs	---	---	---	---	3.0	---
1977B----------- Mora	VIs	---	---	---	---	3.0	---
1978---------- Nokay	VIs	---	---	---	---	3.0	---
1979---------- Parent	VIs	---	---	---	---	4.0	---
1980---------- Ronneby	VIs	---	---	---	---	3.0	---
1998---------- Warman Variant	VIw	---	---	---	---	---	---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Productivity class*	
7A, 7B---------- Hubbard	2A	Slight	Slight	Slight	Slight	Bur oak----------	40	2	Red pine, white spruce, eastern white pine, jack pine, northern red oak.
						Red pine----------	55	6	
						Northern red oak----	---	---	
						Jack pine----------	60	6	
						White spruce--------	55	7	
						Quaking aspen-------	68	---	
12C---------- Emmert	6S	Slight	Slight	Severe	Slight	Red pine----------	52	6	Red pine, jack pine, eastern white pine.
						Quaking aspen-------	---	---	
						Jack pine----------	60	6	
						White spruce--------	55	7	
						Bur oak----------	---	---	
12D---------- Emmert	6R	Moderate	Moderate	Severe	Slight	Red pine----------	52	6	Red pine, jack pine, eastern white pine.
						Quaking aspen-------	---	---	
						Jack pine----------	60	6	
						White spruce--------	55	7	
						Bur oak----------	---	---	
119B, 119C------ Pomroy	4S	Slight	Slight	Moderate	Slight	Northern red oak----	64	4	Jack pine, eastern white pine, red pine, white spruce, white oak, northern red oak.
						Red pine----------	64	4	
						Eastern white pine--	55	7	
						Jack pine----------	64	6	
						White spruce--------	57	8	
142---------- Nokay	5D	Slight	Severe	Slight	Moderate	Quaking aspen-------	68	5	White spruce, red pine, northern red oak.
						Sugar maple---------	60	3	
						American basswood---	65	4	
						Northern red oak----	65	4	
						American elm--------	---	---	
144B, 144C------ Flak	3D	Slight	Moderate	Slight	Moderate	Northern red oak----	58	3	Red pine, white spruce, eastern white pine, northern red oak, jack pine.
						White oak----------	66	4	
						Quaking aspen-------	62	5	
						American elm--------	---	---	
						American basswood---	60	4	
						Jack pine----------	56	6	
144E---------- Flak	3R	Moderate	Moderate	Slight	Moderate	Northern red oak----	58	3	Red pine, white spruce, eastern white pine, northern red oak, jack pine.
						White oak----------	66	4	
						Quaking aspen-------	62	5	
						American elm--------	---	---	
						American basswood---	60	4	
						Jack pine----------	56	6	
152B, 152C------ Milaca	5D	Slight	Moderate	Slight	Moderate	Northern red oak----	72	5	Red pine, white spruce, eastern white pine, northern red oak.
						White oak----------	---	---	
						Red pine----------	55	6	
						Quaking aspen-------	75	6	
						Eastern white pine--	55	7	
						American basswood---	60	4	
						Jack pine----------	55	5	
						Sugar maple---------	52	2	
						American elm--------	---	---	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Productivity class*	Trees to plant
155B, 155C--- Chetek	6A	Slight	Slight	Slight	Slight	Jack pine	57	6	Red pine, jack pine, eastern white pine.
						Northern pin oak	53	3	
						Black oak	---	---	
						Eastern white pine	---	---	
158B--- Zimmerman	3S	Slight	Slight	Moderate	Slight	Northern red oak	53	3	Red pine, eastern white pine, jack pine, balsam fir.
						Bur oak	---	---	
						Paper birch	65	5	
						Quaking aspen	75	6	
						Eastern white pine	76	12	
163B--- Brainerd	4A	Slight	Slight	Slight	Slight	Northern red oak	64	4	Red pine, white spruce, northern red oak, jack pine.
						Quaking aspen	70	6	
						American basswood	60	4	
						American elm	---	---	
						White oak	60	4	
						White spruce	50	7	
						Eastern white pine	48	6	
164B--- Mora	5D	Slight	Severe	Slight	Moderate	Northern red oak	72	5	White spruce, red pine, eastern white pine, northern red oak.
						Red pine	60	7	
						Eastern white pine	55	7	
						White spruce	60	8	
						Sugar maple	55	2	
						Quaking aspen	75	6	
						Jack pine	65	7	
						American elm	---	---	
						White oak	---	---	
166--- Ronneby	4W	Slight	Severe	Slight	Moderate	Northern red oak	60	4	White spruce, northern red oak.
						Quaking aspen	78	6	
						Eastern white pine	55	7	
						Jack pine	50	5	
						American basswood	60	4	
						Sugar maple	55	2	
						Balsam fir	58	8	
						White spruce	50	7	
						American elm	---	---	
182A, 182B--- Oesterle	3W	Slight	Severe	Slight	Moderate	Northern red oak	72	5	Red maple, white ash, white spruce.
						Red maple**	66	3	
						Quaking aspen	78	6	
						Balsam fir	---	---	
						Paper birch	---	---	
						Yellow birch	---	---	
200B, 200C--- Holdingford	4A	Slight	Slight	Slight	Slight	Northern red oak	64	4	Red pine, white spruce, eastern white pine, northern red oak, American basswood.
						Quaking aspen	74	6	
						Bur oak	57	3	
						Slippery elm	70	---	
						American elm	65	---	
						White spruce	59	8	
						American basswood	61	4	
						Sugar maple	57	2	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Productivity class*	
202---------- Meehan	6W	Slight	Moderate	Slight	Moderate	Pin oak----------	---	---	Eastern white pine, jack pine, white spruce, red pine, red maple.
						Quaking aspen**-----	70	6	
						Jack pine----------	60	6	
						Red pine----------	60	7	
						Paper birch---------	60	4	
						American elm--------	75	8	
						Black ash----------	60	7	
204B, 204C------ Cushing	3L	Slight	Moderate	Slight	Slight	Sugar maple---------	60	3	Eastern white pine, Norway spruce, white spruce, northern red oak.
						Yellow birch--------	---	---	
						Eastern white pine--	---	---	
						Red maple----------	---	---	
						American basswood---	---	---	
204E---------- Cushing	3R	Moderate	Moderate	Moderate	Slight	Sugar maple---------	60	3	Eastern white pine, Norway spruce, white spruce, northern red oak.
						Yellow birch--------	---	---	
						Eastern white pine--	---	---	
						Red maple----------	---	---	
						American basswood---	---	---	
218---------- Watab	6S	Slight	Slight	Moderate	Slight	Quaking aspen-------	72	6	White spruce, northern red oak.
						White spruce--------	51	7	
						American basswood---	62	3	
						Sugar maple---------	57	2	
233A, 233B------ Growton	6A	Slight	Slight	Slight	Slight	Quaking aspen-------	75	6	Red pine, eastern white pine, white spruce, northern red oak.
						Eastern white pine--	55	7	
						White spruce--------	59	8	
						Sugar maple---------	57	2	
						Red pine----------	60	7	
264B---------- Freeon	3D	Slight	Moderate	Slight	Moderate	Sugar maple---------	62	3	Red pine, eastern white pine, white spruce, northern red oak.
						Northern red oak----	63	4	
						American basswood---	---	---	
						Red maple----------	---	---	
						White oak----------	---	---	
						Quaking aspen-------	---	---	
						Bigtooth aspen------	---	---	
						White ash----------	---	---	
						American elm--------	---	---	
265---------- Soderville	6W	Slight	Moderate	Moderate	Moderate	Red pine----------	56	6	White spruce, red pine.
						Eastern white pine--	54	7	
						Pin oak----------	---	---	
						White spruce--------	59	8	
266---------- Freer	5W	Slight	Severe	Slight	Moderate	Northern red oak----	71	5	White spruce, northern red oak.
						Quaking aspen-------	75	6	
						White spruce--------	58	8	
						American basswood---	62	4	
						Sugar maple---------	62	3	
						Eastern white pine--	55	7	
						Jack pine----------	60	6	
						Red maple----------	62	3	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Productivity class*	Trees to plant
292--Alstad	4W	Slight	Severe	Slight	Moderate	Northern red oak	64	4	Eastern white pine, white spruce, black spruce, northern red oak.
						Red maple	65	3	
						American basswood	---	---	
						American elm	---	---	
						Quaking aspen	---	---	
						Sugar maple	---	---	
						Bigtooth aspen	---	---	
302B--Rosholt	3L	Slight	Moderate	Slight	Slight	Sugar maple	65	3	Red pine, eastern white pine.
						White ash	77	5	
						American basswood	---	---	
						Northern red oak	69	4	
325--Prebish	3W	Slight	Moderate	Moderate	Severe	Black ash	65	3	Black ash, black spruce, green ash, tamarack.
						Green ash	66	4	
						Slippery elm	58	---	
						Quaking aspen	75	6	
328B, 328C--Sartell	7S	Slight	Moderate	Moderate	Slight	Red pine	59	7	Red pine.
						Eastern white pine	61	9	
						Jack pine	64	6	
337--Warman	7W	Slight	Severe	Severe	Severe	White spruce	50	7	White spruce, black ash, black spruce.
						Black ash	45	2	
						Black spruce	45	3	
						Red maple	45	2	
454B, 454C--Mahtomedi	2S	Slight	Moderate	Moderate	Slight	Northern red oak	48	2	Red pine, jack pine, eastern white pine, white spruce.
						Red pine	64	8	
						White spruce	82	11	
						Jack pine	69	7	
						Eastern white pine	59	8	
						Bigtooth aspen	77	6	
454E--Mahtomedi	2R	Moderate	Moderate	Moderate	Slight	Northern red oak	48	2	Red pine, jack pine, eastern white pine, white spruce.
						Red pine	64	8	
						White spruce	82	11	
						Jack pine	69	7	
						Eastern white pine	59	8	
						Bigtooth aspen	77	6	
454F--Mahtomedi	2R	Severe	Severe	Moderate	Slight	Northern red oak	48	2	Red pine, jack pine, eastern white pine, white spruce.
						Red pine	64	8	
						White spruce	82	11	
						Jack pine	69	7	
						Eastern white pine	59	8	
						Bigtooth aspen	77	6	
458A, 458B, 458C--Menahga	4S	Slight	Moderate	Moderate	Slight	Northern red oak	---	---	Red pine, white spruce, eastern white pine, jack pine.
						Jack pine	59	6	
						Red pine	60	7	
						Eastern white pine	55	7	
						Quaking aspen	65	5	
						Paper birch**	60	4	
458E--Menahga	6R	Moderate	Moderate	Moderate	Slight	Jack pine	59	6	Red pine, white spruce, eastern white pine, jack pine.
						Red pine	60	7	
						Eastern white pine	55	7	
						Quaking aspen	65	5	
						Paper birch	60	4	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Productivity class*	Trees to plant
458F---------- Menahga	6R	Severe	Severe	Moderate	Slight	Jack pine----------	59	6	Red pine, white spruce, eastern white pine, jack pine.
						Red pine----------	60	7	
						Eastern white pine--	55	7	
						Quaking aspen-------	65	5	
						Paper birch---------	60	4	
540---------- Seelyeville	3W	Slight	Severe	Severe	Severe	Black spruce--------	34	3	Black spruce, tamarack, balsam fir, northern whitecedar.
						Tamarack----------	56	4	
						Black ash----------	55	2	
						Northern whitecedar-	30	3	
						Balsam fir----------	45	6	
541---------- Rifle	3W	Slight	Severe	Severe	Severe	Black spruce--------	35	3	Black spruce, tamarack, balsam fir, northern whitecedar.
						Tamarack----------	60	4	
						Northern whitecedar-	30	3	
						Balsam fir----------	45	6	
						Black ash----------	50	2	
543---------- Markey	2W	Slight	Severe	Severe	Severe	Quaking aspen-------	45	2	
						Balsam fir----------	---	---	
						Black spruce--------	---	---	
						Tamarack----------	---	---	
						Black ash----------	---	---	
						Northern whitecedar-	---	---	
						Paper birch---------	---	---	
544---------- Cathro	2W	Slight	Severe	Severe	Severe	Black ash----------	55	2	Black spruce, balsam fir, tamarack, northern whitecedar.
						Tamarack----------	55	4	
						Balsam fir----------	53	7	
						Northern whitecedar-	42	4	
						Black spruce--------	35	3	
549---------- Greenwood	4W	Slight	Severe	Severe	Severe	Black spruce--------	39	4	Black spruce, tamarack.
						Tamarack----------	46	2	
623A, 623B------ Pierz	4A	Slight	Slight	Slight	Slight	Northern red oak----	65	4	Red pine, eastern white pine.
						White ash----------	---	---	
						Sugar maple---------	---	---	
835***:									
Brainerd-------	4D	Slight	Slight	Slight	Moderate	Northern red oak----	64	4	Red pine, white spruce, northern red oak, jack pine.
						Quaking aspen-------	70	6	
						American basswood---	60	4	
						White oak----------	60	4	
						White spruce--------	50	7	
						Eastern white pine--	48	6	
						American elm--------	---	---	
Rock outcrop.									
928B***, 928C***:									
Cushing-------	4L	Slight	Moderate	Slight	Slight	Northern red oak----	64	4	Eastern white pine, Norway spruce, white spruce, northern red oak.
						Sugar maple---------	60	3	
						Yellow birch--------	---	---	
						Eastern white pine--	---	---	
						Red maple----------	---	---	
						American basswood---	---	---	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Productivity class*	Trees to plant
928B***, 928C***:									
Mahtomedi	2S	Slight	Moderate	Moderate	Slight	Northern red oak	48	2	Red pine, jack pine, eastern white pine, white spruce, northern red oak.
						Red pine	64	8	
						White spruce	82	11	
						Jack pine	69	7	
						Eastern white pine	59	8	
						Bigtooth aspen	77	6	
DeMontreville	4S	Slight	Slight	Moderate	Slight	Northern red oak	66	4	Red pine, white spruce, jack pine, northern red oak.
						Red pine	56	6	
						Eastern white pine	54	7	
						Jack pine	60	6	
						White spruce	57	8	
						American basswood	60	4	
						Quaking aspen	72	6	
928E***, 928F***:									
Cushing	4R	Moderate	Moderate	Moderate	Slight	Northern red oak	64	4	Eastern white pine, Norway spruce, white spruce, northern red oak.
						Sugar maple	60	3	
						Yellow birch	---	---	
						Eastern white pine	---	---	
						Red maple	---	---	
						American basswood	---	---	
Mahtomedi	2R	Moderate	Moderate	Moderate	Slight	Northern red oak	48	2	Red pine, jack pine, eastern white pine, white spruce.
						Red pine	64	8	
						White spruce	82	11	
						Jack pine	69	7	
						Eastern white pine	59	8	
						Bigtooth aspen	77	6	
DeMontreville	4R	Moderate	Moderate	Moderate	Slight	Northern red oak	66	4	Red pine, white spruce, jack pine, northern red oak.
						Red pine	56	6	
						Eastern white pine	54	7	
						Jack pine	60	6	
						White spruce	57	8	
						American basswood	60	4	
						Quaking aspen	72	6	
1946***:									
Fordum	2W	Slight	Severe	Severe	Severe	Silver maple	80	2	Silver maple, red maple, white ash.
						Red maple	---	---	
						White ash	---	---	
						Northern whitecedar	---	---	
						Tamarack	---	---	
						Black spruce	---	---	
						Balsam fir	---	---	
						White spruce	---	---	
Winterfield	5W	Slight	Severe	Moderate	Severe	Quaking aspen	65	5	White spruce, eastern white pine, black spruce, northern whitecedar.
						Paper birch	55	4	
						Balsam fir	55	8	
						Black ash	55	2	
						American elm	---	---	
						White spruce	55	7	
						Eastern white pine	---	---	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Productivity class*	Trees to plant
1973***:									
Meehan	6W	Slight	Moderate	Slight	Moderate	Northern red oak	66	---	Eastern white pine, jack pine, red pine, white spruce, balsam fir, red pine, red maple.
						Jack pine**	60	6	
						Red pine	60	7	
						Quaking aspen	70	6	
						Paper birch	60	4	
						Balsam fir	59	8	
						Eastern white pine	55	7	
Isan.									
1976B	4X	Slight	Moderate	Slight	Slight	Northern red oak	64	4	Red pine, white spruce, northern red oak, jack pine.
Brainerd						Quaking aspen	70	6	
						American basswood	60	4	
						American elm	---	---	
						White oak	60	4	
						White spruce	50	7	
						Eastern white pine	48	6	
1977B	5X	Slight	Severe	Slight	Moderate	Northern red oak	72	5	White spruce, red pine, eastern white pine.
Mora						Red pine	60	7	
						Eastern white pine	55	7	
						White spruce	60	8	
						Sugar maple	55	2	
						Quaking aspen	75	6	
						Jack pine	65	7	
1978	4X	Slight	Severe	Slight	Moderate	Northern red oak	65	4	White spruce, red pine, northern red oak.
Nokay						Quaking aspen	68	5	
						Sugar maple	60	3	
						American basswood	65	4	
1980	4X	Slight	Severe	Slight	Moderate	Northern red oak	60	4	White spruce, northern red oak.
Ronneby						Quaking aspen	78	6	
						Eastern white pine	55	7	
						Jack pine	50	5	
						American basswood	60	4	
						Sugar maple	55	2	
						Balsam fir	58	8	
						White spruce	50	7	

* Productivity class is the yield in cubic meters per hectare per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

** This species is the indicator species.

*** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
7A Hubbard	Slight	Slight	Slight	Slight	Severe: droughty.
7B Hubbard	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
12C Emmert	Moderate: slope.	Moderate: slope.	Severe: slope, small stones.	Slight	Severe: small stones, droughty.
12D Emmert	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Slight	Severe: small stones, droughty.
25 Becker	Severe: flooding.	Slight	Slight	Slight	Slight.
119B Pomroy	Moderate: percs slowly, too sandy.	Moderate: too sandy, percs slowly.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
119C Pomroy	Moderate: slope, percs slowly.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.
142 Nokay	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
144B Flak	Slight	Slight	Severe: slope.	Slight	Moderate: droughty.
144C Flak	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
144E Flak	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
152B Milaca	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Moderate: droughty.
152C Milaca	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: droughty, slope.
155B Chetek	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones, droughty.
155C Chetek	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, droughty, slope.
158B Zimmerman	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
161 Isanti	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
163B Brainerd	Moderate: wetness.	Moderate: wetness.	Moderate: slope, small stones, wetness.	Moderate: wetness.	Moderate: wetness, droughty.
164B Mora	Moderate: wetness.	Moderate: wetness.	Moderate: slope, small stones, wetness.	Slight	Slight.
165 Parent	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
166 Ronneby	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: small stones, wetness.	Moderate: wetness.	Moderate: wetness.
182A, 182B Oesterle	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: large stones, wetness, droughty.
200B Holdingford	Slight	Slight	Severe: slope.	Slight	Slight.
200C Holdingford	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
202 Meehan	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.	Moderate: wetness, droughty.
204B Cushing	Slight	Slight	Severe: slope.	Slight	Moderate: large stones.
204C Cushing	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
204E Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
217 Nokasippi	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
218 Watab	Moderate: wetness, percs slowly, too sandy.	Moderate: wetness, too sandy, percs slowly.	Moderate: too sandy, wetness.	Moderate: wetness, too sandy.	Moderate: wetness, droughty.
233A Growton	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
233B Growton	Slight	Slight	Moderate: slope.	Slight	Slight.
260 Duelm	Moderate: wetness.	Moderate: wetness.	Moderate: small stones, wetness.	Slight	Moderate: droughty.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
261 Isan	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
264B Freeon	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight	Slight.
265 Soderville	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.	Moderate: too sandy, wetness.	Moderate: too sandy.	Moderate: droughty.
266 Freer	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
292 Alstad	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
302B Rosholt	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Slight	Moderate: small stones, large stones.
325 Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
328B Sartell	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
328C Sartell	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.
337 Warman	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
341A Arvilla	Slight	Slight	Slight	Slight	Moderate: droughty.
341B Arvilla	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
375 Forada	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
413 Osakis	Slight	Slight	Slight	Slight	Moderate: droughty.
454B Mahtomedi	Moderate: small stones.	Moderate: too sandy.	Severe: small stones.	Moderate: too sandy.	Moderate: small stones.
454C Mahtomedi	Moderate: slope.	Moderate: slope.	Severe: slope, small stones.	Moderate: too sandy.	Moderate: small stones.
454E Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: too sandy.	Severe: slope.
454F Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.	Severe: slope.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
458A Menahga	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: droughty.
458B Menahga	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
458C Menahga	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: slope, droughty.
458E Menahga	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope, too sandy.	Severe: slope.
458F Menahga	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
540 Seelyeville	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
541 Rifle	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
543 Markey	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
544 Cathro	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
549 Greenwood	Severe: wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness.	Severe: wetness, excess humus.	Severe: wetness, excess humus.
623A Pierz	Slight	Slight	Moderate: small stones.	Slight	Slight.
623B Pierz	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
835*: Brainerd	Moderate: wetness.	Moderate: wetness.	Moderate: slope, small stones, wetness.	Moderate: wetness.	Moderate: wetness.
Rock outcrop.					
928B*: Cushing	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: large stones.
Mahtomedi	Moderate: small stones.	Moderate: too sandy.	Severe: small stones.	Moderate: too sandy.	Moderate: small stones.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
928B*:					
DeMontreville	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, small stones.	Moderate: too sandy.	Moderate: droughty.
928C*:					
Cushing	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: large stones, slope.
Mahtomedi	Moderate: slope.	Moderate: slope.	Severe: slope, small stones.	Moderate: too sandy.	Moderate: small stones.
DeMontreville	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.
928E*:					
Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: too sandy.	Severe: slope.
DeMontreville	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too sandy, slope.	Severe: slope.
928F*:					
Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Mahtomedi	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.	Severe: slope.
DeMontreville	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1015. Psamments					
1016. Udorthents					
1030*:					
Pits.					
Udorthents.					
1934 Bowstring	Severe: flooding, wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness, flooding.	Severe: wetness, excess humus.	Severe: wetness, flooding, excess humus.
1946*:					
Fordum	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding, flooding.	Severe: ponding.	Severe: ponding, flooding.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1946*:					
Winterfield	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
1973*:					
Meehan	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.	Moderate: wetness, droughty.
Isan	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1976B					
Brainerd	Moderate: wetness.	Moderate: wetness.	Moderate: large stones, slope, small stones.	Moderate: wetness.	Moderate: large stones, wetness, droughty.
1977B					
Mora	Moderate: wetness.	Moderate: wetness.	Moderate: large stones, slope, small stones.	Slight	Moderate: large stones, droughty.
1978					
Nokay	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: large stones, wetness.
1979					
Parent	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1980					
Ronneby	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: large stones, small stones, wetness.	Moderate: wetness.	Moderate: large stones, wetness.
1998					
Warman Variant	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
7A, 7B---------- Hubbard	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Fair	Very poor.
12C---------- Emmert	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
12D---------- Emmert	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
25---------- Becker	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Good.
119B, 119C---------- Pomroy	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
142---------- Nokay	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
144B, 144C---------- Flak	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
144E---------- Flak	Poor	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
152B, 152C---------- Milaca	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
155B, 155C---------- Chetek	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
158B---------- Zimmerman	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
161---------- Isanti	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
163B---------- Brainerd	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
164B---------- Mora	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
165---------- Parent	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
166---------- Ronneby	Fair	Fair	Good	Good	Good	Good	Good	Fair	Good	Good.
182A, 182B---------- Oesterle	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
200B, 200C---------- Holdingford	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
202---------- Meehan	Poor	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
204B, 204C--------- Cushing	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
204E--------- Cushing	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
217--------- Nokasippi	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
218--------- Watab	Fair	Fair	Good	Good	Fair	Fair	Fair	Fair	Good	Fair.
233A, 233B--------- Growton	Good	Good	Good	Good	Good	Poor	Poor	Good	Fair	Poor.
260--------- Duelm	Poor	Fair	Good	Fair	Good	Fair	Fair	Poor	Good	Fair.
261--------- Isan	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
264B--------- Freeon	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
265--------- Soderville	Poor	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Poor	Fair.
266--------- Freer	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
292--------- Alstad	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
302B--------- Rosholt	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
325--------- Prebish	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
328B, 328C--------- Sartell	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
337--------- Warman	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
341A, 341B--------- Arvilla	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
375--------- Forada	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
413--------- Osakis	Fair	Fair	Fair	Poor	Poor	Poor	Poor	Fair	Poor	Poor.
454B, 454C--------- Mahtomedi	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
454E, 454F--------- Mahtomedi	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
458A, 458B, 458C--- Menahga	Poor	Poor	Fair	Poor	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
458E, 458F--------- Menahga	Very poor.	Poor	Fair	Poor	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
540---------- Seelyeville	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
541---------- Rifle	Fair	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
543---------- Markey	Very poor.	Very poor.	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
544---------- Cathro	Poor	Fair	Fair	Fair	Fair	Good	Good	Poor	Fair	Good.
549---------- Greenwood	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
623A--------- Pierz	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
623B--------- Pierz	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
835*: Brainerd----------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Rock outcrop.										
928B*: Cushing----------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Mahtomedi---------	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
DeMontreville-----	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
928C*: Cushing----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Mahtomedi---------	Poor	Fair	Fair	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.
DeMontreville-----	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.
928E*, 928F*: Cushing----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Mahtomedi---------	Very poor.	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
DeMontreville-----	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
1015. Psamments										
1016. Udorthents										
1030*: Pits.										
Udorthents.										
1934--- Bowstring	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
1946*: Fordum---	Very poor.	Very poor.	Poor	Fair	Fair	Good	Good	Very poor.	Fair	Good.
Winterfield---	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
1973*: Meehan---	Poor	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
Isan---	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
1976B--- Brainerd	Fair	Good	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
1977B--- Mora	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
1978--- Nokay	Fair	Good	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
1979--- Parent	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
1980--- Ronneby	Poor	Fair	Good	Good	Good	Good	Good	Fair	Good	Good.
1998--- Warman Variant	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
7A Hubbard	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
7B Hubbard	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
12C Emmert	Severe: cutbanks cave.	Moderate: slope, large stones.	Moderate: slope, large stones.	Severe: slope.	Moderate: slope, large stones.	Severe: small stones, droughty.
12D Emmert	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: small stones, droughty.
25 Becker	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding, frost action.	Slight.
119B Pomroy	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
119C Pomroy	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
142 Nokay	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
144B Flak	Moderate: dense layer.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Moderate: droughty.
144C Flak	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: droughty, slope.
144E Flak	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
152B Milaca	Moderate: dense layer.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Moderate: droughty.
152C Milaca	Moderate: dense layer, slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: droughty, slope.
155B Chetek	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: large stones, droughty.
155C Chetek	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: large stones, droughty, slope.
158B Zimmerman	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
161---------- Isanti	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
163B---------- Brainerd	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
164B---------- Mora	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
165---------- Parent	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
166---------- Ronneby	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Moderate: wetness.
182A, 182B-------- Oesterle	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: large stones, wetness, droughty.
200B---------- Holdingford	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
200C---------- Holdingford	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
202---------- Meehan	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
204B---------- Cushing	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: large stones.
204C---------- Cushing	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
204E---------- Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
217---------- Nokasippi	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
218---------- Watab	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
233A---------- Growton	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
233B---------- Growton	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
260---------- Duelm	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: droughty.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
261---------- Isan	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
264B---------- Freeon	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Slight.
265---------- Soderville	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: droughty.
266---------- Freer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
292---------- Alstad	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
302B---------- Rosholt	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Moderate: small stones, large stones.
325---------- Prebish	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
328B---------- Sartell	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
328C---------- Sartell	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
337---------- Warman	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
341A---------- Arvilla	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
341B---------- Arvilla	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
375---------- Forada	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
413---------- Osakis	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Moderate: frost action.	Moderate: droughty.
454B---------- Mahtomedi	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: small stones.
454C---------- Mahtomedi	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: small stones.
454E, 454F-------- Mahtomedi	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
458A---------- Menahga	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
458B---------- Menahga	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
458C---------- Menahga	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope, droughty.
458E, 458F-------- Menahga	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
540---------- Seelyeville	Severe: excess humus, ponding.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, excess humus.
541---------- Rifle	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
543---------- Markey	Severe: cutbanks cave, excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
544---------- Cathro	Severe: excess humus, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
549---------- Greenwood	Severe: excess humus, wetness.	Severe: wetness, low strength, subsides.	Severe: wetness, low strength, subsides.	Severe: wetness, low strength, subsides.	Severe: wetness, frost action, subsides.	Severe: wetness, excess humus.
623A---------- Pierz	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
623B---------- Pierz	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
835*: Brainerd---------	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: wetness.
Rock outcrop.						
928B*: Cushing----------	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: large stones.
Mahtomedi--------	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: small stones.
DeMontreville----	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
928C*:						
Cushing	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: large stones, slope.
Mahtomedi	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: small stones.
DeMontreville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
928E*, 928F*:						
Cushing	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Mahtomedi	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
DeMontreville	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1015. Psamments						
1016. Udorthents						
1030*: Pits.						
Udorthents.						
1934 Bowstring	Severe: cutbanks cave, excess humus, wetness.	Severe: subsides, flooding, wetness.	Severe: subsides, flooding, wetness.	Severe: subsides, flooding, wetness.	Severe: subsides, wetness, flooding.	Severe: wetness, flooding, excess humus.
1946*:						
Fordum	Severe: cutbanks cave, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: ponding, flooding, frost action.	Severe: ponding, flooding.
Winterfield	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.
1973*:						
Meehan	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.	Moderate: wetness, droughty.
Isan	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1976B---------- Brainerd	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, frost action.	Moderate: large stones, wetness, droughty.
1977B---------- Mora	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Moderate: large stones, droughty.
1978---------- Nokay	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: large stones, wetness.
1979---------- Parent	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
1980---------- Ronneby	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Moderate: large stones, wetness.
1998---------- Warman Variant	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	Severe: ponding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
7A, 7B Hubbard	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
12C Emmert	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
12D Emmert	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
25 Becker	Severe: poor filter.	Severe: seepage.	Severe: seepage, wetness, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
119B Pomroy	Severe: percs slowly.	Severe: seepage.	Slight	Severe: seepage.	Fair: small stones.
119C Pomroy	Severe: percs slowly.	Severe: seepage, slope.	Moderate: slope.	Severe: seepage.	Fair: small stones, slope.
142 Nokay	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Poor: wetness.
144B Flak	Severe: percs slowly.	Severe: seepage.	Slight	Slight	Fair: small stones.
144C Flak	Severe: percs slowly.	Severe: seepage, slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
144E Flak	Severe: percs slowly, slope.	Severe: seepage, slope.	Severe: slope.	Severe: slope.	Poor: slope.
152B Milaca	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
152C Milaca	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
155B Chetek	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
155C---------- Chetek	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
158B---------- Zimmerman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
161---------- Isanti	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
163B---------- Brainerd	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness.	Moderate: wetness.	Fair: small stones, wetness.
164B---------- Mora	Severe: wetness, percs slowly.	Moderate: seepage, slope.	Moderate: wetness.	Moderate: wetness.	Fair: small stones, wetness.
165---------- Parent	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Severe: wetness.	Poor: wetness.
166---------- Ronneby	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Moderate: wetness.	Fair: small stones, wetness.
182A, 182B---------- Oesterle	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
200B---------- Holdingford	Moderate: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Fair: small stones.
200C---------- Holdingford	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
202---------- Meehan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
204B---------- Cushing	Severe: percs slowly.	Moderate: seepage, slope.	Slight----------	Slight----------	Fair: small stones.
204C---------- Cushing	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
204E---------- Cushing	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
217---------- Nokasippi	Severe: ponding, percs slowly, poor filter.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
218---------- Watab	Severe: wetness, percs slowly, poor filter.	Severe: seepage.	Severe: wetness, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
233A---------- Growton	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
233B---------- Growton	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
260---------- Duelm	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
261---------- Isan	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
264B---------- Freeon	Severe: wetness, percs slowly.	Moderate: seepage, slope.	Moderate: wetness.	Moderate: wetness.	Poor: small stones.
265---------- Soderville	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
266---------- Freer	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Severe: wetness.	Poor: wetness.
292---------- Alstad	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
302B---------- Rosholt	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
325---------- Prebish	Severe: ponding, percs slowly.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
328B---------- Sartell	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
328C---------- Sartell	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
337---------- Warman	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, small stones.
341A, 341B---------- Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
375---------- Forada	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
413---------- Osakis	Severe: poor filter, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
454B---------- Mahtomedi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
454C---------- Mahtomedi	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
454E, 454F---------- Mahtomedi	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
458A, 458B---------- Menahga	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
458C---------- Menahga	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
458E, 458F---------- Menahga	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
540---------- Seelyeville	Severe: ponding, subsides.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: ponding, excess humus.
541---------- Rifle	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
543---------- Markey	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
544 Cathro	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
549 Greenwood	Severe: wetness, subsides.	Severe: seepage, excess humus, wetness.	Severe: seepage, wetness, excess humus.	Severe: seepage, wetness.	Poor: wetness, excess humus.
623A, 623B Pierz	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
835*: Brainerd	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage.	Moderate: wetness.	Fair: area reclaim, small stones, wetness.
Rock outcrop.					
928B*: Cushing	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
Mahtomedi	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
DeMontreville	Severe: percs slowly.	Severe: seepage.	Slight	Severe: seepage.	Fair: small stones.
928C*: Cushing	Severe: percs slowly.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: small stones, slope.
Mahtomedi	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
DeMontreville	Severe: percs slowly.	Severe: seepage, slope.	Moderate: slope.	Severe: seepage.	Fair: small stones, slope.
928E*, 928F*: Cushing	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Mahtomedi	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
928E*, 928F*: DeMontreville	Severe: percs slowly, slope.	Severe: seepage, slope.	Severe: slope.	Severe: seepage, slope.	Poor: slope.
1015. Psamments					
1016. Udorthents					
1030*: Pits.					
Udorthents.					
1934 Bowstring	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: wetness, excess humus.
1946*: Fordum	Severe: flooding, ponding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: seepage, too sandy, ponding.
Winterfield	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.
1973*: Meehan	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
Isan	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
1976B Brainerd	Severe: wetness, percs slowly.	Moderate: seepage, slope.	Severe: wetness.	Moderate: wetness.	Fair: small stones, wetness.
1977B Mora	Severe: wetness, percs slowly.	Moderate: seepage, slope.	Moderate: wetness.	Moderate: wetness.	Fair: small stones, wetness.
1978 Nokay	Severe: wetness, percs slowly.	Severe: seepage.	Severe: wetness.	Severe: wetness.	Poor: wetness.
1979 Parent	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Severe: wetness.	Poor: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1980 Ronneby	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Moderate: wetness.	Fair: small stones, wetness.
1998 Warman Variant	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
7A, 7B Hubbard	Good	Probable	Improbable: too sandy.	Poor: too sandy.
12C Emmert	Fair: large stones.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
12D Emmert	Poor: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
25 Becker	Good	Probable	Improbable: too sandy.	Fair: small stones, area reclaim, thin layer.
119B, 119C Pomroy	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
142 Nokay	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
144B, 144C Flak	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
144E Flak	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
152B, 152C Milaca	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
155B, 155C Chetek	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
158B Zimmerman	Good	Probable	Improbable: too sandy.	Poor: too sandy.
161 Isanti	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
163B Brainerd	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
164B Mora	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
165 Parent	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
166 Ronneby	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
182A, 182B Oesterle	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
200B, 200C Holdingford	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
202 Meehan	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
204B, 204C Cushing	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
204E Cushing	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
217 Nokasippi	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
218 Watab	Fair: wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: too sandy.
233A Growton	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
233B Growton	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
260 Duelm	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
261 Isan	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
264B Freeon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
265 Soderville	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
266 Freer	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim, area reclaim.
292 Alstad	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
302B Rosholt	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
325 Prebish	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
328B, 328C Sartell	Good	Probable	Improbable: too sandy.	Poor: too sandy.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
337 Warman	Poor: wetness.	Probable	Probable	Poor: small stones, area reclaim, wetness.
341A, 341B Arvilla	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
375 Forada	Fair: wetness.	Probable	Probable	Poor: small stones.
413 Osakis	Good	Probable	Probable	Poor: small stones, area reclaim.
454B, 454C Mahtomedi	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
454E Mahtomedi	Fair: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
454F Mahtomedi	Poor: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
458A, 458B, 458C Menahga	Good	Probable	Improbable: too sandy.	Poor: too sandy.
458E Menahga	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope, too sandy.
458F Menahga	Poor: slope.	Probable	Improbable: too sandy.	Poor: slope, too sandy.
540 Seelyeville	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
541 Rifle	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
543 Markey	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
544 Cathro	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
549 Greenwood	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
623A, 623B---------- Pierz	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim.
835*: Brainerd----------	Fair: area reclaim, thin layer, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Rock outcrop.				
928B*, 928C*: Cushing----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Mahtomedi----------	Good----------	Probable----------	Probable----------	Poor: too sandy, small stones, area reclaim.
DeMontreville--------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, small stones.
928E*: Cushing----------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Mahtomedi----------	Fair: slope.	Probable----------	Probable----------	Poor: too sandy, small stones, area reclaim.
DeMontreville--------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, small stones, slope.
928F*: Cushing----------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
Mahtomedi----------	Poor: slope.	Probable----------	Probable----------	Poor: too sandy, small stones, area reclaim.
DeMontreville--------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: too sandy, small stones, slope.
1015. Psamments				
1016. Udorthents				

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1030*:				
Pits.				
Udorthents.				
1934---------- Bowstring	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
1946*:				
Fordum----------	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: small stones, wetness.
Winterfield----------	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: too sandy, wetness.
1973*:				
Meehan----------	Fair: wetness.	Probable----------	Improbable: too sandy.	Poor: too sandy.
Isan----------	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: too sandy, wetness.
1976B---------- Brainerd	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
1977B---------- Mora	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
1978---------- Nokay	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
1979---------- Parent	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
1980---------- Ronneby	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
1998---------- Warman Variant	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
7A---------- Hubbard	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake.	Too sandy, soil blowing.	Droughty.
7B---------- Hubbard	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
12C, 12D---------- Emmert	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, large stones, droughty.	Slope, large stones, too sandy.	Large stones, slope, droughty.
25---------- Becker	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing---	Too sandy, soil blowing.	Favorable.
119B---------- Pomroy	Severe: seepage.	Severe: piping.	Deep to water	Slope, droughty, fast intake.	Rooting depth, soil blowing.	Droughty, rooting depth.
119C---------- Pomroy	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope, droughty, fast intake.	Slope, rooting depth, soil blowing.	Slope, droughty, rooting depth.
142---------- Nokay	Moderate: seepage.	Severe: piping.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, rooting depth.	Wetness, rooting depth, percs slowly.
144B---------- Flak	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope, droughty, soil blowing.	Soil blowing, percs slowly.	Droughty, rooting depth.
144C, 144E-------- Flak	Severe: slope.	Severe: piping.	Deep to water	Slope, droughty, soil blowing.	Slope, soil blowing, percs slowly.	Slope, droughty, rooting depth.
152B---------- Milaca	Moderate: slope.	Severe: piping.	Deep to water	Slope, droughty, soil blowing.	Percs slowly---	Droughty.
152C---------- Milaca	Severe: slope.	Severe: piping.	Deep to water	Slope, droughty, soil blowing.	Slope, percs slowly.	Slope, droughty.
155B---------- Chetek	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
155C---------- Chetek	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
158B---------- Zimmerman	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake.	Too sandy, soil blowing.	Droughty.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
161---------- Isanti	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Wetness, droughty.
163B---------- Brainerd	Moderate: seepage.	Severe: piping.	Percs slowly---	Wetness, droughty.	Wetness, soil blowing.	Rooting depth, droughty.
164B---------- Mora	Moderate: seepage.	Severe: piping.	Percs slowly, frost action.	Wetness, soil blowing.	Wetness, soil blowing, percs slowly.	Rooting depth, percs slowly.
165---------- Parent	Moderate: seepage.	Severe: piping, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, rooting depth, percs slowly.
166---------- Ronneby	Moderate: seepage.	Severe: piping.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness--------	Rooting depth, percs slowly.
182A, 182B-------- Oesterle	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness, droughty, soil blowing.	Wetness, too sandy, soil blowing.	Wetness, droughty.
200B---------- Holdingford	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope, soil blowing, rooting depth.	Soil blowing---	Rooting depth.
200C---------- Holdingford	Severe: slope.	Severe: piping.	Deep to water	Slope, soil blowing, rooting depth.	Slope, soil blowing.	Slope, rooting depth.
202---------- Meehan	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
204B---------- Cushing	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Soil blowing, slope.	Soil blowing---	Favorable.
204C, 204E-------- Cushing	Severe: slope.	Severe: thin layer.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
217---------- Nokasippi	Severe: seepage.	Severe: piping, ponding.	Ponding, percs slowly, frost action.	Ponding, droughty, fast intake.	Ponding, soil blowing.	Wetness, droughty, rooting depth.
218---------- Watab	Severe: seepage.	Severe: seepage, piping.	Percs slowly, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, rooting depth, too sandy.	Droughty, rooting depth, percs slowly.
233A---------- Growton	Moderate: seepage.	Severe: piping, wetness.	Frost action---	Wetness, soil blowing, rooting depth.	Wetness, soil blowing.	Wetness, rooting depth.
233B---------- Growton	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope, soil blowing, rooting depth.	Soil blowing---	Rooting depth.
260---------- Duelm	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
261---------- Isan	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, cutbanks cave.	Ponding, droughty.	Ponding, too sandy, soil blowing.	Wetness, droughty.
264B---------- Freeon	Moderate: seepage.	Severe: seepage, piping.	Percs slowly---	Wetness--------	Erodes easily, wetness.	Erodes easily, rooting depth.
265---------- Soderville	Severe: seepage.	Severe: seepage, piping.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Droughty, rooting depth.
266---------- Freer	Moderate: seepage.	Severe: piping.	Percs slowly, frost action.	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, rooting depth.
292---------- Alstad	Moderate: seepage.	Severe: thin layer.	Frost action---	Wetness, erodes easily.	Wetness, erodes easily.	Wetness, erodes easily.
302B---------- Rosholt	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty-------	Too sandy------	Droughty, rooting depth.
325---------- Prebish	Slight---------	Severe: piping, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
328B---------- Sartell	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
328C---------- Sartell	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
337---------- Warman	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding, rooting depth.	Ponding, too sandy.	Wetness, rooting depth.
341A---------- Arvilla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
341B---------- Arvilla	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
375---------- Forada	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
413---------- Osakis	Severe: seepage.	Severe: seepage.	Deep to water	Droughty-------	Too sandy------	Droughty.
454B---------- Mahtomedi	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty, rooting depth.
454C, 454E, 454F-- Mahtomedi	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy.	Slope, droughty, rooting depth.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
458A---------- Menahga	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
458B---------- Menahga	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
458C, 458E, 458F-- Menahga	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
540---------- Seelyeville	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides.	Ponding--------	Ponding--------	Wetness.
541---------- Rifle	Severe: seepage.	Severe: excess humus, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
543---------- Markey	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
544---------- Cathro	Severe: seepage.	Severe: piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
549---------- Greenwood	Severe: seepage.	Severe: excess humus, wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
623A---------- Pierz	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing---	Too sandy, soil blowing.	Favorable.
623B---------- Pierz	Severe: seepage.	Severe: seepage.	Deep to water	Slope, soil blowing.	Too sandy, soil blowing.	Favorable.
835*:						
Brainerd---------	Moderate: depth to rock, seepage, slope.	Severe: piping.	Slope----------	Slope, wetness, soil blowing.	Wetness, soil blowing.	Rooting depth.
Rock outcrop.						
928B*:						
Cushing----------	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Soil blowing, slope.	Soil blowing---	Favorable.
Mahtomedi--------	Severe: seepage.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty, rooting depth.
DeMontreville----	Severe: seepage.	Moderate: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Soil blowing---	Droughty, rooting depth.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
928C*, 928E*, 928F*:						
Cushing	Severe: slope.	Severe: thin layer.	Deep to water	Soil blowing, slope.	Slope, soil blowing.	Slope.
Mahtomedi	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy.	Slope, droughty, rooting depth.
DeMontreville	Severe: seepage, slope.	Moderate: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, soil blowing.	Slope, droughty, rooting depth.
1015. Psamments						
1016. Udorthents						
1030*: Pits.						
Udorthents.						
1934 Bowstring	Severe: seepage.	Severe: excess humus, wetness.	Flooding, subsides, frost action.	Wetness, flooding.	Wetness	Wetness.
1946*:						
Fordum	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, flooding, frost action.	Ponding, flooding.	Ponding, too sandy.	Wetness.
Winterfield	Severe: seepage.	Severe: seepage, piping, wetness.	Flooding, cutbanks cave.	Wetness, droughty.	Wetness, too sandy, soil blowing.	Wetness, droughty.
1973*:						
Meehan	Severe: seepage.	Severe: seepage, piping, wetness.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Wetness, droughty.
Isan	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, cutbanks cave.	Ponding, droughty.	Ponding, too sandy, soil blowing.	Wetness, droughty.
1976B Brainerd	Moderate: seepage.	Severe: piping.	Percs slowly	Wetness, droughty.	Wetness, percs slowly.	Droughty, rooting depth.
1977B Mora	Moderate: seepage.	Severe: piping.	Percs slowly, frost action.	Wetness, droughty.	Wetness, percs slowly.	Droughty, rooting depth, percs slowly.
1978 Nokay	Moderate: seepage.	Severe: piping.	Percs slowly, frost action.	Wetness, percs slowly, rooting depth.	Wetness, percs slowly.	Wetness, rooting depth, percs slowly.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
1979---------- Parent	Moderate: seepage.	Severe: piping, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, rooting depth, percs slowly.
1980---------- Ronneby	Moderate: seepage.	Severe: piping.	Percs slowly, frost action.	Wetness, percs slowly, rooting depth.	Wetness--------	Rooting depth, percs slowly.
1998---------- Warman Variant	Slight---------	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding--------	Wetness, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
7A, 7B----------	0-14	Loamy sand-------	SM, SP-SM	A-2	0	98-100	95-100	50-80	10-25	<20	NP
Hubbard	14-37	Sand, coarse sand, loamy sand.	SP-SM, SW-SM	A-1, A-3, A-2-4	0	98-100	85-100	25-75	5-12	<20	NP
	37-60	Sand, coarse sand	SP, SW	A-1, A-3, A-2	0	95-100	85-100	20-70	2-5	<20	NP
12C, 12D---------	0-4	Gravelly loamy sand.	SM, SP, GW, GP	A-1	0-10	45-90	40-75	10-50	0-20	<25	NP
Emmert	4-60	Very gravelly coarse sand, very gravelly sand, gravelly coarse sand.	GW, GP, SP, SW	A-1	0-30	20-60	10-45	5-25	0-5	---	NP
25----------	0-15	Fine sandy loam	ML, SM	A-4	0	100	95-100	75-95	40-55	<25	NP-4
Becker	15-32	Sandy loam, fine sandy loam, loam.	ML, SM	A-4	0	100	85-100	75-95	35-70	<25	NP-4
	32-36	Loamy coarse sand, loamy fine sand, gravelly loamy coarse sand.	SM	A-2, A-1	0	95-100	65-100	35-75	15-35	<20	NP
	36-60	Coarse sand, fine sand, loamy fine sand.	SM, SP-SM	A-1, A-2, A-3	0	95-100	65-100	35-70	5-15	<20	NP
119B, 119C-------	0-9	Loamy fine sand	SM	A-2, A-1-b	0	100	95-100	45-80	15-35	---	NP
Pomroy	9-26	Fine sand, sand, loamy fine sand.	SM, SP-SM	A-2, A-1-b	0	100	95-100	45-80	10-35	---	NP
	26-42	Fine sandy loam, sandy loam.	SM	A-4, A-2	0-10	85-95	70-95	50-70	25-45	<22	NP-4
	42-60	Sandy loam, fine sandy loam.	SM	A-4, A-2	0-5	85-95	70-95	50-70	25-40	<22	NP-4
142----------	0-6	Loam----------	ML, CL-ML	A-4	0-2	90-100	80-100	60-90	50-75	20-30	2-7
Nokay	6-14	Sandy loam, fine sandy loam, loam.	SM, ML	A-2, A-4	0-5	85-95	75-95	60-80	25-55	<25	NP-4
	14-31	Sandy loam, fine sandy loam, loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0-5	85-95	75-95	60-80	25-55	20-30	2-7
	31-41	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	60-75	25-40	<25	NP-4
	41-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	60-75	25-40	<25	NP-4
144B, 144C, 144E-	0-7	Sandy loam-------	SM	A-2, A-4	0-2	90-100	80-100	60-80	25-45	<22	NP-4
Flak	7-15	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	50-75	25-40	<22	NP-4
	15-23	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4
	23-43	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4
	43-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
152B, 152C------- Milaca	0-5	Fine sandy loam	SM	A-4	0-2	90-100	80-100	60-80	35-50	<22	NP-4
	5-17	Fine sandy loam, very fine sandy loam.	SM	A-4	0-2	90-100	80-100	60-80	35-50	<22	NP-4
	17-27	Sandy loam, fine sandy loam, loam.	SM	A-2, A-4	0-5	85-95	75-95	50-70	30-40	<22	NP-4
	27-36	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	50-70	30-40	<22	NP-4
	36-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	50-70	25-40	<22	NP-4
155B, 155C------- Chetek	0-6	Sandy loam-------	SM, SM-SC	A-2, A-4	0-15	80-100	75-100	45-70	25-40	<23	NP-6
	6-10	Sandy loam, loam	ML, CL, SM, SC	A-2, A-4	0-15	80-100	75-100	45-95	25-75	<26	NP-8
	10-20	Sandy loam, loam	ML, CL, SM, SC	A-2, A-4, A-6, A-1	0-15	80-100	75-100	45-95	10-75	<31	NP-13
	20-60	Stratified sand to gravel.	SP, SP-SM	A-1	0-15	55-95	45-75	15-50	1-5	---	NP
158B------------- Zimmerman	0-6	Loamy fine sand	SM	A-2	0	100	100	95-100	15-30	<20	NP
	6-60	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	95-100	5-20	<20	NP
161-------------- Isanti	0-16	Fine sandy loam	SM	A-4, A-2	0	100	100	75-100	15-40	<20	NP
	16-34	Fine sand, sand, loamy fine sand.	SM, SP-SM	A-2	0	100	100	85-100	10-35	<20	NP
	34-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	100	85-100	5-35	<20	NP
163B------------- Brainerd	0-6	Sandy loam-------	SM	A-2, A-4	0-2	90-100	80-100	60-85	25-45	<22	NP-4
	6-11	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0-4	85-95	75-93	50-75	25-40	<22	NP-7
	11-23	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0-4	85-95	75-95	50-70	25-40	<22	NP-7
	23-41	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-2	85-95	75-95	50-70	25-40	<22	NP-4
	41-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-2	85-95	75-95	50-70	25-40	<22	NP-4
164B------------- Mora	0-5	Fine sandy loam	SM, ML	A-4	0-2	90-100	80-100	70-90	40-60	<20	NP-4
	5-11	Fine sandy loam, sandy loam, loam.	SM, ML	A-4	0-2	90-100	80-100	70-90	40-80	<20	NP-4
	11-25	Fine sandy loam, sandy loam, loam.	SM, ML	A-4	0-2	90-100	80-100	70-90	40-60	<20	NP-4
	25-44	Fine sandy loam, sandy loam.	SM	A-4, A-2	0-4	85-100	70-90	60-80	30-40	<20	NP-4
	44-60	Fine sandy loam, sandy loam.	SM	A-4, A-2	0-4	85-100	70-90	60-80	30-40	<20	NP-4
165-------------- Parent	0-15	Loam-------------	ML, CL, CL-ML	A-4, A-6	0-2	90-100	85-100	75-90	50-80	20-40	3-15
	15-26	Fine sandy loam, sandy loam, loam.	SM, ML	A-2, A-4	0-5	85-95	75-90	55-75	30-55	<20	NP-4
	26-40	Fine sandy loam, sandy loam.	SM	A-2, A-4	2-13	75-95	75-90	40-75	25-45	<20	NP-4
	40-60	Fine sandy loam, sandy loam.	SM	A-2, A-4	1-10	75-95	75-90	40-75	25-45	<20	NP-4

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
166---------- Ronneby	0-5	Loam----------	ML	A-4	0-5	95-100	80-100	75-95	50-75	<25	NP-4
	5-11	Sandy loam, fine sandy loam, loam.	SM, ML	A-4	0-5	85-100	80-95	60-85	35-65	<25	NP-4
	11-32	Fine sandy loam, sandy loam, loam.	SM, ML, SM-SC, CL-ML	A-4	0-5	85-95	70-85	60-85	35-60	20-30	2-7
	32-45	Sandy loam, fine sandy loam.	SM	A-4, A-2	0-5	85-95	70-90	60-80	25-50	<20	NP-4
	45-60	Sandy loam, fine sandy loam.	SM	A-4, A-2	0-5	85-95	70-95	60-80	25-50	<20	NP-4
182A, 182B------- Oesterle	0-6	Sandy loam-------	SM, SC, ML, CL	A-2, A-4, A-1	0-7	80-100	75-100	45-95	20-65	<26	3-8
	6-9	Sandy loam, loam, fine sandy loam.	CL-ML, CL, SM-SC, SC	A-2, A-4, A-1	0-7	75-100	70-100	40-95	20-75	20-30	4-10
	9-23	Sandy loam, loamy sand, gravelly loamy sand.	SM, SP-SM, SM-SC, GM	A-2, A-1	0-7	55-95	55-95	25-75	10-35	<23	NP-6
	23-60	Gravelly sand, sand, loamy sand, very gravelly coarse sand.	SW, SP, GW, GP	A-1, A-3, A-2	0-7	35-95	35-95	15-70	0-30	---	NP
200B, 200C------- Holdingford	0-8	Sandy loam-------	SM	A-2	0-2	95-100	85-100	60-70	25-35	<20	NP-4
	8-17	Sandy loam, fine sandy loam.	SM	A-2	0-2	95-100	85-100	60-70	25-35	<20	NP-4
	17-49	Fine sandy loam, sandy loam, loam.	SM, SC, ML, CL	A-4	5-10	90-100	75-95	60-90	35-70	15-30	2-10
	49-60	Sandy loam, fine sandy loam, loam.	SM, ML, CL-ML, SM-SC	A-4	3-7	90-100	75-95	60-90	35-70	<20	NP-5
202---------- Meehan	0-7	Loamy sand-------	SM	A-2, A-1	0	90-100	75-100	40-90	15-30	---	NP
	7-28	Sand, loamy sand, loamy coarse sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	90-100	75-100	40-90	3-30	---	NP
	28-60	Sand, coarse sand	SP, SP-SM	A-1, A-3, A-2	0	90-100	75-100	40-90	0-5	---	NP
204B, 204C, 204E- Cushing	0-5	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-4, A-2, A-1	0-7	75-100	75-100	45-95	20-65	<25	2-7
	5-19	Loam, fine sandy loam, sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1	0-7	75-100	75-100	35-100	12-90	<23	NP-6
	19-42	Loam, sandy clay loam, sandy loam.	SC, CL	A-2, A-4, A-6, A-7	0-7	75-100	75-100	45-95	20-75	25-45	9-27
	42-60	Loam, sandy clay loam, sandy loam.	SC, CL, SM, ML	A-2, A-4, A-6, A-1	0-7	75-100	75-100	45-95	20-75	<34	2-20

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
217---------- Nokasippi	0-12	Mucky loamy fine sand, loamy fine sand.	SM	A-2	0	100	95-100	65-90	15-35	---	NP
	12-27	Loamy fine sand, fine sand, sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	55-90	5-35	---	NP
	27-33	Sandy loam, fine sandy loam, loam.	SM, SC, ML, CL	A-4, A-2-4	0-5	80-100	70-90	45-85	25-60	<30	NP-10
	33-48	Sandy loam, fine sandy loam.	SM	A-4, A-2-4	0-10	80-95	70-90	50-85	25-50	<22	NP-4
	48-60	Sandy loam, fine sandy loam.	SM	A-4, A-2-4	0-5	80-100	70-90	50-85	25-50	<22	NP-4
218---------- Watab	0-8	Loamy fine sand	SM	A-2-4	0	100	95-100	75-90	15-25	<20	NP
	8-30	Loamy fine sand, loamy sand, sand.	SM, SP-SM	A-3, A-1-b, A-2-4	0	95-100	95-100	10-90	5-35	<20	NP
	30-39	Sandy loam, fine sandy loam, gravelly sandy loam.	SM, SM-SC	A-2-4, A-4	0-10	80-95	70-90	50-85	25-50	<20	1-5
	39-51	Sandy loam, fine sandy loam, gravelly sandy loam.	SM, SM-SC	A-2-4, A-4	0-10	80-95	70-90	50-85	25-50	<20	1-5
	51-60	Sandy loam, fine sandy loam, gravelly sandy loam.	SM, SM-SC	A-2-4, A-4	0-5	80-95	70-90	50-85	25-50	<20	1-5
233A, 233B------- Growton	0-9	Sandy loam-------	SM, SM-SC	A-4, A-2	0-5	95-100	90-100	75-95	15-45	<20	NP-5
	9-19	Fine sandy loam, sandy loam.	SM, SM-SC	A-4, A-2	0-5	95-100	90-100	75-95	15-45	<20	NP-5
	19-44	Fine sandy loam, sandy loam, loam.	CL, SC, SM-SC, CL-ML	A-4	0-5	95-100	90-100	50-80	40-80	<30	4-10
	44-60	Sandy loam, loam	SM, SM-SC	A-4, A-2	0-5	80-95	80-95	60-80	10-45	<25	4-7
260---------- Duelm	0-11	Loamy sand-------	SM, SP-SM	A-2, A-1	0	90-100	85-100	35-80	10-25	<20	NP
	11-33	Loamy sand, coarse sand, sand.	SM, SP-SM	A-2, A-3, A-1	0	90-100	80-100	35-80	5-25	<20	NP
	33-60	Coarse sand, sand	SP, SM, SP-SM	A-2, A-3, A-1	0	90-100	80-100	35-85	3-15	<20	NP
261---------- Isan	0-8	Sandy loam-------	SM-SC, SM	A-2	0	95-100	92-100	50-75	15-35	<20	2-5
	8-25	Sand, loamy sand	SM, SP-SM	A-2	0	95-100	92-100	50-75	10-30	<20	NP
	25-60	Sand, coarse sand	SM, SP	A-1, A-2, A-3	0	85-100	80-100	35-70	2-15	<20	NP
264B---------- Freeon	0-7	Silt loam--------	ML, CL, CL-ML	A-4	0-5	90-100	90-100	85-100	85-100	<30	1-10
	7-20	Silt loam, very fine sandy loam.	ML, CL, CL-ML	A-4	0-5	90-100	90-100	80-100	50-100	<30	1-10
	20-27	Silt loam--------	ML, CL, CL-ML	A-4	0-5	90-100	90-100	85-100	85-100	<30	1-10
	27-35	Loam, sandy loam, gravelly sandy loam.	SM, SC, ML, CL	A-4, A-6, A-2, A-1	0-15	65-100	65-95	35-90	10-70	<35	NP-15
	35-60	Sandy loam, loam, gravelly sandy loam.	SM, SC, ML, CL	A-4, A-2, A-6, A-1	0-15	65-95	60-95	35-90	10-70	<35	NP-15

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
265---------- Soderville	0-8	Loamy fine sand	SM, SP-SM	A-2	0	100	100	95-100	10-35	---	NP
	8-31	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	95-100	8-35	---	NP
	31-49	Fine sand, loamy fine sand, fine sandy loam.	SM, SP-SM	A-2, A-3	0	100	100	95-100	6-35	---	NP
	49-60	Fine sand, sand	SP, SP-SM, SM	A-2, A-3	0	100	85-100	85-100	2-20	---	NP
266---------- Freer	0-4	Silt loam--------	ML, CL-ML, CL	A-4, A-6	0-5	95-100	90-100	90-100	80-100	25-40	5-12
	4-11	Silt loam, loam, very fine sandy loam.	ML, CL-ML, CL	A-4	0-5	95-100	90-100	90-100	80-100	<30	1-10
	11-22	Silt loam, loam, very fine sandy loam.	ML, CL-ML, CL	A-4, A-6	0-5	95-100	90-100	90-100	80-100	25-40	5-12
	22-33	Loam, fine sandy loam, sandy loam.	CL-ML, CL	A-4, A-6	1-10	90-100	80-95	60-90	50-65	25-35	4-12
	33-44	Sandy loam, fine sandy loam.	SM	A-2, A-4	1-10	90-100	80-95	50-85	25-50	<20	NP-4
	44-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	1-10	90-100	70-95	50-80	25-50	<20	NP-4
292---------- Alstad	0-9	Loam----------	CL, CL-ML, ML	A-4	0	95-100	95-100	80-100	55-100	<28	3-9
	9-13	Silt loam, loam, sandy loam.	ML, CL, SM, SC	A-2, A-4	0	95-100	95-100	55-100	25-100	<26	2-8
	13-21	Loam, silt loam, silty clay loam.	CL, SC	A-4, A-6, A-7	0	80-100	75-100	65-100	45-95	25-45	9-27
	21-54	Sandy clay loam, clay loam, loam.	CL, SC	A-6, A-4, A-2, A-7	0	80-100	75-100	60-100	25-80	20-45	9-28
	54-60	Loam, sandy clay loam, sandy loam.	SC, CL, SM, ML	A-6, A-4, A-2, A-1	0-3	80-100	75-100	45-95	20-75	<35	2-20
302B---------- Rosholt	0-10	Silt loam--------	SM-SC, CL-ML, SM, ML	A-4	0-8	75-100	70-100	60-95	45-90	<25	3-7
	10-16	Sandy loam, loam, silt loam.	SM, ML, SM-SC, CL-ML	A-2, A-4, A-1	0-8	75-100	70-100	35-95	12-90	<25	NP-6
	16-23	Sandy loam, loam	SC, SM, CL, ML	A-2, A-4, A-1, A-6	0-8	75-100	70-100	35-95	12-75	<30	NP-13
	23-26	Gravelly loamy sand, sandy loam, fine sandy loam.	SM, GM, SP-SM, GP-GM	A-1, A-2, A-4	0-10	50-100	45-100	25-80	10-50	<25	NP-7
	26-60	Stratified sand to gravel.	GP, SP, SP-SM, GP-GM	A-1, A-2, A-3	0-25	20-100	20-100	10-65	0-10	---	NP
325---------- Prebish	0-13	Loam----------	ML, CL-ML	A-4	0-2	95-100	90-100	75-90	50-75	20-35	3-10
	13-42	Sandy loam, fine sandy loam, loam.	SM	A-4, A-2	0-5	80-95	77-90	45-80	25-50	<20	NP-4
	42-60	Sandy loam, fine sandy loam.	SM	A-2	0-10	80-95	77-85	55-70	20-35	<20	NP-4

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
328B, 328C------- Sartell	0-7 7-39 39-60	Loamy fine sand Fine sand, sand Fine sand, sand	SM, SP-SM SP-SM, SM SP, SP-SM	A-2, A-3 A-2, A-3 A-3, A-2	0 0 0	100 100 100	100 100 100	90-100 90-100 85-95	7-20 7-20 1-12	--- --- ---	NP NP NP
337---------- Warman	0-12 12-33 33-60	Loam, very fine sandy loam. Loam, silt loam, fine sandy loam. Gravelly sand, gravelly coarse sand, sand.	OL, ML, CL-ML ML, CL-ML GW, GP, SP, SW	A-4 A-4 A-1	0-5 0-5 0-15	95-100 95-100 45-95	90-100 90-100 35-95	65-90 65-90 5-50	50-85 50-85 2-25	<30 25-35 ---	NP-5 NP-5 NP
341A, 341B------- Arvilla	0-10 10-18 18-60	Sandy loam------- Sandy loam, loam, coarse sandy loam. Gravelly coarse sand, coarse sand, very gravelly coarse sand.	SM, SC, SM-SC SM, SC, SM-SC SP-SM, GP, SP, GP-GM	A-2, A-4, A-6 A-2, A-4, A-6 A-1, A-2, A-3	0 0 0	95-100 95-100 35-100	90-100 90-100 25-100	50-80 50-80 10-60	20-45 20-45 0-10	<30 <30 ---	NP-15 NP-15 NP
375---------- Forada	0-16 16-21 21-60	Loam---------- Sandy loam, loam, fine sandy loam. Sand, coarse sand, gravelly coarse sand.	ML ML, SM SP, SM, SP-SM, GP-GM	A-4 A-4, A-2 A-1, A-2, A-3	0 0 0	95-100 95-100 50-90	85-100 85-100 50-80	70-90 55-85 40-70	50-70 30-60 2-30	25-35 20-40 ---	NP-10 NP-10 NP
413---------- Osakis	0-10 10-19 19-60	Loam---------- Loam, sandy loam Coarse sand, gravelly coarse sand, very gravelly coarse sand.	ML, CL, SM, SC SM, ML, CL-ML, SM-SC SP, SP-SM, GP, GP-GM	A-4, A-2 A-4, A-2 A-1	0 0 0-5	95-100 95-100 30-95	85-100 85-100 30-85	70-95 55-90 10-50	30-75 25-70 0-10	20-35 20-35 <20	2-10 1-8 NP
454B, 454C, 454E, 454F---------- Mahtomedi	0-5 5-35 35-60	Loamy sand------- Sand, coarse sand, gravelly sand. Sand, coarse sand, gravelly sand.	SM, SM-SC SP-SM, SM SP, SM, SP-SM	A-2, A-1 A-2, A-3, A-1 A-2, A-3, A-1	0-2 0-15 0-15	95-100 70-95 55-95	60-90 50-90 50-90	40-86 30-75 30-70	15-30 5-15 2-15	<20 <20 <20	NP-4 NP NP
458A, 458B, 458C, 458E, 458F------ Menahga	0-5 5-60	Loamy sand------- Coarse sand, sand	SM, SP-SM SP, SP-SM	A-2 A-3, A-2, A-1	0 0	100 100	85-100 80-100	60-80 30-75	10-30 0-10	--- ---	NP NP
540---------- Seelyeville	0-12 12-60	Muck---------- Sapric material	PT PT	A-8 A-8	0 0	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---
541---------- Rifle	0-7 7-60	Mucky peat------- Hemic material---	PT PT	A-8 A-8	0 0	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
543----------	0-33	Muck----------	PT	A-8	0	---	---	---	---	---	---
Markey	33-60	Sand, loamy sand, fine sand.	SP, SM, SP-SM	A-2, A-3	0	100	85-100	60-75	0-20	---	NP
544----------	0-7	Muck----------	PT	A-8	0	---	---	---	---	---	---
Cathro	7-25	Sapric material	PT	A-8	0	---	---	---	---	---	---
	25-60	Sandy loam, loam, silt loam.	SM, ML, SC, CL	A-4	0-5	80-100	65-100	60-100	35-90	<25	3-10
549----------	0-12	Fibric material	PT	A-8	0	---	---	---	---	---	---
Greenwood	12-60	Hemic material---	PT	A-8	0	---	---	---	---	---	---
623A, 623B-------	0-14	Sandy loam-------	SM, SM-SC, ML, CL-ML	A-4, A-2-4	0-5	90-100	85-100	60-85	30-55	<25	NP-5
Pierz	14-28	Sandy loam, loam, fine sandy loam.	SC, SM-SC, CL-ML, CL	A-4, A-6	0-10	80-100	65-95	60-95	35-90	15-30	4-14
	28-60	Very gravelly coarse sand, gravelly coarse sand, gravelly sand.	GW, GP, SP, SW	A-1, A-2-4, A-3	0-10	35-75	25-75	20-60	3-15	---	NP
835*:											
Brainerd--------	0-6	Sandy loam-------	SM	A-2, A-4	0-2	90-100	80-100	60-85	25-45	<22	NP-4
	6-18	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-4	85-95	75-95	50-75	25-40	<22	NP-4
	18-46	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-4	85-95	75-95	50-70	25-40	<22	NP-4
	46-60	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
928B*, 928C*, 928E*, 928F*:											
Cushing--------	0-5	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-4, A-2, A-1	0-7	75-100	75-100	45-95	20-65	<25	2-7
	5-19	Loam, fine sandy loam, sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1	0-7	75-100	75-100	35-100	12-90	<23	NP-6
	19-42	Loam, sandy clay loam, sandy loam.	SC, CL	A-2, A-4, A-6, A-7	0-7	75-100	75-100	45-95	20-75	25-45	9-27
	42-60	Loam, sandy clay loam, sandy loam.	SC, CL, SM, ML	A-2, A-4, A-6, A-1	0-7	75-100	75-100	45-95	20-75	<34	2-20
Mahtomedi------	0-5	Loamy sand-------	SM, SM-SC	A-2, A-1	0-2	95-100	60-90	40-86	15-30	<20	NP-4
	5-38	Sand, coarse sand, gravelly sand.	SP-SM, SM	A-2, A-3, A-1	0-15	70-95	50-90	30-75	5-15	<20	NP
	38-60	Sand, coarse sand, gravelly sand.	SP, SM, SP-SM	A-2, A-3, A-1	0-15	55-95	50-90	30-70	2-15	<20	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
928B*, 928C*, 928E*, 928F*:											
DeMontreville--	0-6	Loamy fine sand	SM	A-2	0-5	90-100	85-100	65-80	20-35	<20	NP
	6-33	Loamy sand, sand, fine sand.	SP, SP-SM, SM	A-2, A-3	0-5	90-100	85-100	60-80	2-35	<20	NP
	33-46	Sandy loam, sandy clay loam, loam.	SC, SM, CL, ML	A-2, A-4	0-5	80-100	70-90	55-70	20-55	15-25	3-10
	46-60	Sandy loam, coarse sandy loam.	SC, SM, SM-SC	A-2, A-4	0-5	80-100	70-90	45-65	25-45	15-25	3-8
1015. Psamments											
1016. Udorthents											
1030*: Pits.											
Udorthents.											
1934---------- Bowstring	0-4	Muck----------	PT	A-8	0	---	---	---	---	---	---
	4-8	Sand, fine sand, fine sandy loam.	SP-SM, SM, SM-SC	A-2	0	100	100	50-85	10-35	<20	NP-5
	8-41	Sapric material	PT	A-8	0	---	---	---	---	---	---
	41-60	Sand, fine sand, fine sandy loam.	SP-SM, SM	A-2	0	100	100	50-95	10-35	<20	NP-5
1946*:											
Fordum----------	0-8	Silt loam--------	ML, CL, SM, SC	A-4, A-6	0-15	80-100	75-100	65-100	45-95	20-35	3-15
	8-50	Silt loam, fine sandy loam, loam.	SM, SC, ML, CL	A-2, A-4, A-1	0-15	80-100	75-100	45-100	20-90	<30	3-10
	50-60	Sand, fine sand, loamy fine sand.	SP, SM	A-3, A-2, A-1	0-15	80-100	75-100	35-80	2-35	---	NP
Winterfield-----	0-4	Loamy sand-------	SM, SM-SC	A-2-4, A-4	0	100	95-100	50-90	15-45	<25	NP-7
	4-29	Sand, loamy sand, loamy fine sand.	SM, SP-SM, SM-SC	A-2-4, A-3, A-4	0	100	95-100	50-90	5-45	<25	NP-7
	29-60	Sand, gravelly sand, loamy fine sand.	SM, SP-SM, SP	A-3, A-1-b, A-2-4	0	85-100	70-100	35-80	0-35	---	NP
1973*:											
Meehan----------	0-7	Loamy sand-------	SM	A-2, A-1	0	90-100	75-100	40-90	15-30	---	NP
	7-28	Sand, loamy sand, loamy coarse sand.	SM, SP-SM, SP	A-1, A-2, A-3	0	90-100	75-100	40-90	3-30	---	NP
	28-60	Sand, coarse sand	SP, SP-SM	A-1, A-3, A-2	0	90-100	75-100	40-90	0-5	---	NP
Isan----------	0-13	Sandy loam-------	SM-SC, SM	A-2	0	95-100	92-100	50-75	15-35	<20	2-5
	13-25	Sand, loamy sand	SM, SP-SM	A-2	0	95-100	92-100	50-75	10-30	<20	NP
	25-60	Sand, coarse sand	SM, SP	A-1, A-2, A-3	0	85-100	80-100	35-70	2-15	<20	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
1976B---------- Brainerd	0-4	Sandy loam-------	SM	A-2, A-4	3-15	90-100	80-95	60-85	25-45	<22	NP-4
	4-14	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-4	85-95	75-93	50-75	25-40	<22	NP-4
	14-26	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-4	85-95	75-95	50-70	25-40	<22	NP-4
	26-33	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-2	85-95	75-95	50-70	25-40	<22	NP-4
	33-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-2	85-95	75-95	50-70	25-40	<22	NP-4
1977B---------- Mora	0-4	Fine sandy loam	SM	A-4	2-15	90-100	80-95	60-85	35-50	<20	NP-4
	4-15	Fine sandy loam, sandy loam, loam.	SM, ML	A-4	0-2	90-100	80-100	70-90	40-60	<20	NP-4
	15-32	Fine sandy loam, sandy loam.	SM, ML	A-4	0-2	90-100	80-100	70-90	40-60	<20	NP-4
	32-49	Fine sandy loam, sandy loam.	SM	A-4, A-2	0-4	85-100	70-90	60-80	30-40	<20	NP-4
	49-60	Fine sandy loam, sandy loam.	SM	A-4, A-2	0-4	85-100	70-90	60-80	30-40	<20	NP-4
1978---------- Nokay	0-5	Loam----------	ML, CL-ML	A-4	3-15	90-100	80-100	60-90	50-75	20-30	2-7
	5-17	Sandy loam, fine sandy loam, loam.	SM, ML	A-2, A-4	0-5	85-95	75-95	60-80	25-55	<25	NP-4
	17-30	Sandy loam, fine sandy loam, loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0-5	85-95	75-95	60-80	25-55	20-30	2-7
	30-40	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	60-75	25-40	<25	NP-4
	40-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	0-5	85-95	75-95	60-75	25-40	<25	NP-4
1979---------- Parent	0-6	Loam----------	ML, CL, CL-ML	A-4, A-6	3-15	90-100	85-100	75-90	50-80	20-40	3-15
	6-33	Loam, sandy loam, fine sandy loam.	SM, ML	A-2, A-4	0-5	85-95	75-90	55-75	30-55	<20	NP-4
	33-42	Sandy loam, fine sandy loam.	SM	A-2, A-4	2-13	75-95	75-90	40-75	25-45	<20	NP-4
	42-60	Sandy loam, fine sandy loam.	SM	A-2, A-4	1-10	75-95	75-90	40-75	25-45	<20	NP-4
1980---------- Ronneby	0-4	Loam----------	ML	A-4	3-15	85-100	80-100	75-95	50-75	<25	NP-4
	4-11	Fine sandy loam, sandy loam, loam.	SM, ML	A-4	0-5	85-95	70-85	60-85	35-65	<25	NP-4
	11-28	Fine sandy loam, sandy loam, loam.	SM, ML, CL-ML, SM-SC	A-4	0-5	85-95	70-85	60-85	35-60	20-30	2-7
	28-38	Sandy loam, fine sandy loam.	SM	A-4, A-2	0-5	85-95	70-90	60-80	25-50	<20	NP-4
	38-60	Sandy loam, fine sandy loam.	SM	A-4, A-2	0-5	85-95	70-95	60-80	25-50	<20	NP-4
1998---------- Warman Variant	0-10	Silty clay loam	CL	A-7, A-6	0	100	100	95-100	85-95	30-50	15-35
	10-14	Silty clay, clay, silty clay loam.	CH, CL, MH	A-7, A-6	0	100	100	95-100	85-95	30-70	15-35
	14-31	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	90-100	90-95	45-70	25-50
	31-60	Silty clay loam, silty clay.	CH, CL, MH	A-7	0	100	95-100	90-100	85-95	40-70	15-35

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
7A, 7B	0-14	4-10	1.45-1.60	6.0-20	0.08-0.12	5.1-7.3	Low	0.15	5	2	2-5
Hubbard	14-37	1-5	1.55-1.65	6.0-20	0.03-0.07	5.1-7.3	Low	0.15			
	37-60	0-5	1.55-1.65	6.0-20	0.03-0.07	6.1-7.3	Low	0.15			
12C, 12D	0-4	1-5	1.45-1.60	>20	0.06-0.10	5.1-6.5	Low	0.10	2	8	.5-1
Emmert	4-60	1-3	1.55-1.65	>20	0.02-0.04	5.1-7.3	Low	0.10			
25	0-15	5-18	1.45-1.55	2.0-6.0	0.16-0.20	5.6-7.3	Low	0.20	4	3	2-5
Becker	15-32	5-18	1.45-1.55	2.0-6.0	0.15-0.20	5.6-7.3	Low	0.20			
	32-36	2-10	1.55-1.65	6.0-20	0.05-0.10	6.1-7.8	Low	0.15			
	36-60	1-10	1.60-1.70	6.0-20	0.02-0.07	6.1-7.8	Low	0.15			
119B, 119C	0-9	5-12	1.40-1.50	6.0-20	0.10-0.12	5.1-6.5	Low	0.15	4	2	.5-1
Pomroy	9-26	2-10	1.50-1.70	6.0-20	0.06-0.09	5.1-6.5	Low	0.15			
	26-42	6-18	1.65-1.90	0.2-0.6	0.08-0.13	5.1-6.5	Low	0.15			
	42-60	5-18	1.80-2.00	<0.2	0.-0.04	5.6-7.3	Low	0.24			
142	0-6	6-18	1.30-1.50	0.6-2.0	0.18-0.22	4.5-5.5	Low	0.32	4	5	3-8
Nokay	6-14	5-15	1.45-1.70	0.6-6.0	0.12-0.19	4.5-5.5	Low	0.28			
	14-31	8-18	1.45-1.80	0.6-2.0	0.12-0.19	5.1-6.5	Low	0.28			
	31-41	4-18	1.75-1.90	0.06-0.2	0.03-0.08	5.6-7.3	Low	0.28			
	41-60	4-18	1.80-2.00	<0.2	0.-0.04	5.6-7.3	Low	0.28			
144B, 144C, 144E	0-7	5-18	1.40-1.60	2.0-6.0	0.13-0.18	4.5-6.5	Low	0.28	4	3	.5-2
Flak	7-15	5-18	1.45-1.70	2.0-6.0	0.12-0.16	5.1-6.5	Low	0.28			
	15-23	8-18	1.45-1.80	0.6-2.0	0.12-0.16	5.1-6.5	Low	0.28			
	23-43	4-18	1.75-1.90	0.06-0.2	0.03-0.08	5.1-6.5	Low	0.28			
	43-60	4-18	1.80-2.00	<0.2	0.-0.04	5.6-6.5	Low	0.28			
152B, 152C	0-5	8-15	1.40-1.60	2.0-6.0	0.13-0.18	5.1-6.5	Low	0.28	4	3	.5-1
Milaca	5-17	8-15	1.40-1.60	2.0-6.0	0.18-0.22	5.1-6.5	Low	0.28			
	17-27	8-18	1.45-1.65	0.6-2.0	0.12-0.16	5.1-6.5	Low	0.28			
	27-36	8-18	1.75-1.90	0.06-0.2	0.03-0.08	5.6-7.3	Low	0.28			
	36-60	6-18	1.80-2.00	<0.2	0.-0.04	6.1-7.3	Low	0.28			
155B, 155C	0-6	4-12	1.35-1.70	2.0-6.0	0.10-0.15	5.1-6.5	Low	0.24	3	3	1-3
Chetek	6-10	4-15	1.40-1.70	2.0-6.0	0.09-0.19	5.1-6.5	Low	0.24			
	10-20	10-18	1.60-1.70	2.0-6.0	0.09-0.19	5.1-6.5	Low	0.24			
	20-60	1-6	1.50-1.60	>6.0	0.02-0.04	5.1-6.5	Low	0.10			
158B	0-6	2-10	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low	0.17	5	2	.5-1
Zimmerman	6-60	2-10	1.50-1.70	6.0-20	0.06-0.10	6.1-7.3	Low	0.17			
161	0-16	5-10	1.30-1.50	6.0-20	0.13-0.18	5.1-6.5	Low	0.17	5	3	3-15
Isanti	16-34	2-10	1.45-1.65	6.0-20	0.06-0.08	5.1-6.5	Low	0.17			
	34-60	1-5	1.50-1.70	6.0-20	0.05-0.07	5.6-6.5	Low	0.17			
163B	0-6	8-18	1.40-1.60	2.0-6.0	0.13-0.18	4.5-6.0	Low	0.28	4	3	.5-4
Brainerd	6-11	5-15	1.45-1.70	2.0-6.0	0.12-0.16	4.5-6.0	Low	0.28			
	11-23	8-18	1.45-1.80	0.6-2.0	0.12-0.16	5.1-6.5	Low	0.28			
	23-41	4-18	1.75-1.90	0.06-0.2	0.03-0.08	5.1-7.3	Low	0.28			
	41-60	4-18	1.80-2.00	<0.2	0.-0.04	5.6-7.3	Low	0.28			
164B	0-5	5-15	1.30-1.60	2.0-6.0	0.15-0.17	5.1-6.5	Low	0.28	4	3	.5-3
Mora	5-11	6-18	1.40-1.70	0.6-6.0	0.14-0.19	5.1-6.5	Low	0.28			
	11-25	8-18	1.50-1.70	0.6-2.0	0.15-0.19	5.6-6.5	Low	0.28			
	25-44	4-18	1.70-1.90	0.06-0.2	0.03-0.08	5.6-6.5	Low	0.28			
	44-60	4-18	1.80-2.00	<0.2	0.-0.04	5.6-7.8	Low	0.28			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
165---	0-15	12-30	1.30-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.32	4	6	4-7
Parent	15-26	5-18	1.50-1.65	0.6-2.0	0.12-0.17	5.6-7.3	Low	0.28			
	26-40	5-18	1.75-1.90	0.06-0.2	0.03-0.08	6.1-8.4	Low	0.28			
	40-60	5-18	1.90-2.00	<0.2	0.-0.04	6.1-8.4	Low	0.28			
166---	0-5	5-18	1.30-1.60	0.6-2.0	0.18-0.23	5.1-6.5	Low	0.32	4	5	3-8
Ronneby	5-11	5-18	1.40-1.60	0.6-6.0	0.12-0.19	5.1-6.5	Low	0.28			
	11-32	6-18	1.45-1.75	0.6-2.0	0.12-0.19	5.6-6.5	Low	0.28			
	32-45	4-18	1.70-1.90	0.06-0.2	0.03-0.08	6.1-7.3	Low	0.28			
	45-60	4-18	1.80-2.00	<0.2	0.-0.04	6.1-8.4	Low	0.28			
182A, 182B---	0-6	8-15	1.40-1.70	0.6-6.0	0.10-0.15	4.5-6.5	Low	0.24	4	3	2-3
Oesterle	6-9	10-18	1.55-1.65	0.6-6.0	0.09-0.19	4.5-6.5	Low	0.24			
	9-23	6-12	1.55-1.70	0.6-6.0	0.05-0.13	4.5-6.5	Low	0.24			
	23-60	1-6	1.55-1.70	>6.0	0.02-0.09	5.1-6.5	Low	0.10			
200B, 200C---	0-8	7-15	1.30-1.50	0.6-2.0	0.13-0.15	5.1-7.3	Low	0.24	5	3	1-3
Holdingford	8-17	7-15	1.40-1.60	0.6-2.0	0.11-0.14	5.1-7.3	Low	0.24			
	17-49	10-18	1.60-1.80	0.6-2.0	0.12-0.19	5.1-7.3	Low	0.24			
	49-60	9-14	1.60-1.80	0.6-2.0	0.12-0.14	7.4-8.4	Low	0.24			
202---	0-7	4-10	1.35-1.65	6.0-20	0.10-0.12	3.6-6.5	Low	0.17	5	2	.5-3
Meehan	7-28	4-9	1.60-1.70	6.0-20	0.06-0.11	5.1-7.3	Low	0.17			
	28-60	1-4	1.60-1.70	6.0-20	0.02-0.07	5.1-7.3	Low	0.17			
204B, 204C, 204E-	0-5	6-14	1.35-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low	0.24	5	3	1-2
Cushing	5-19	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low	0.32			
	19-42	18-35	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low	0.32			
	42-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low	0.32			
217---	0-12	3-12	1.45-1.55	6.0-20	0.10-0.12	5.1-6.5	Low	0.17	4	2	1-10
Nokasippi	12-27	1-12	1.44-1.65	6.0-20	0.06-0.12	5.1-7.3	Low	0.17			
	27-33	3-18	1.55-1.75	0.6-6.0	0.11-0.18	5.1-7.3	Low	0.17			
	33-48	5-16	1.75-1.90	0.06-0.2	0.03-0.08	5.1-7.3	Low	0.17			
	48-60	5-16	1.80-2.00	<0.2	0.-0.04	5.1-7.3	Low	0.17			
218---	0-8	3-12	1.40-1.50	6.0-20	0.10-0.12	5.1-6.0	Low	0.17	4	2	.5-2
Watab	8-30	1-10	1.50-1.70	6.0-20	0.06-0.09	5.1-6.5	Low	0.15			
	30-39	5-16	1.55-1.90	0.6-6.0	0.08-0.12	5.1-6.5	Low	0.28			
	39-51	5-16	1.75-1.90	0.06-0.2	0.03-0.08	5.1-7.3	Low	0.28			
	51-60	5-16	1.80-2.00	<0.2	0.-0.04	5.1-7.3	Low	0.28			
233A, 233B---	0-9	7-11	1.35-1.55	2.0-6.0	0.13-0.16	5.1-7.3	Low	0.24	5	3	1-3
Growton	9-19	7-11	1.40-1.70	2.0-6.0	0.11-0.15	5.1-7.3	Low	0.24			
	19-44	10-18	1.55-1.70	0.6-2.0	0.12-0.19	5.1-7.3	Low	0.32			
	44-60	9-18	1.60-1.75	0.6-2.0	0.12-0.17	7.4-8.4	Low	0.32			
260---	0-11	2-10	1.40-1.60	6.0-20	0.08-0.12	5.6-7.3	Low	0.17	5	2	2-6
Duelm	11-33	1-8	1.55-1.65	6.0-20	0.06-0.11	5.1-7.3	Low	0.15			
	33-60	0-6	1.55-1.65	6.0-20	0.02-0.07	5.6-7.3	Low	0.15			
261---	0-8	5-14	1.30-1.55	6.0-20	0.10-0.15	5.6-7.3	Low	0.17	5	3	3-10
Isan	8-25	2-8	1.50-1.65	6.0-20	0.06-0.10	5.1-6.5	Low	0.17			
	25-60	1-5	1.55-1.70	6.0-20	0.04-0.06	5.6-7.3	Low	0.17			
264B---	0-7	5-18	1.25-1.55	0.6-2.0	0.20-0.24	4.5-7.3	Low	0.37	5	5	1-3
Freeon	7-20	5-18	1.30-1.60	0.6-2.0	0.18-0.22	4.5-7.3	Low	0.37			
	20-27	5-18	1.35-1.65	0.6-2.0	0.18-0.22	4.5-6.5	Low	0.37			
	27-35	3-27	1.70-1.80	0.06-0.2	0.08-0.18	4.5-6.5	Low	0.37			
	35-60	3-27	1.80-1.95	<0.06	0	5.1-7.8	Low	0.28			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
265----------	0-8	2-10	1.40-1.60	6.0-20	0.10-0.12	5.1-6.0	Low----------	0.15	5	2	.5-1
Soderville	8-31	2-10	1.45-1.70	6.0-20	0.06-0.08	5.1-6.0	Low----------	0.15			
	31-49	6-12	1.45-1.75	6.0-20	0.06-0.11	5.1-6.0	Low----------	0.15			
	49-60	2-5	1.45-1.75	6.0-20	0.05-0.10	5.6-6.5	Low----------	0.15			
266----------	0-4	10-20	1.40-1.60	0.6-2.0	0.20-0.24	4.5-6.0	Low----------	0.37	4	5	.5-2
Freer	4-11	10-18	1.45-1.65	0.6-2.0	0.18-0.22	4.5-6.0	Low----------	0.37			
	11-22	18-28	1.40-1.60	0.6-2.0	0.14-0.21	5.1-6.0	Low----------	0.37			
	22-33	18-28	1.50-1.70	0.6-2.0	0.17-0.19	5.1-6.0	Low----------	0.37			
	33-44	5-18	1.70-1.85	0.06-0.2	0.03-0.08	6.1-7.3	Low----------	0.28			
	44-60	5-18	1.80-2.00	<0.06	0.-0.04	6.1-7.3	Low----------	0.28			
292----------	0-9	7-18	1.35-1.60	0.6-2.0	0.20-0.24	5.1-7.3	Low----------	0.37	5	5	2-4
Alstad	9-13	6-16	1.55-1.65	0.6-2.0	0.13-0.22	5.1-7.3	Low----------	0.32			
	13-21	18-35	1.55-1.65	0.6-2.0	0.14-0.22	5.1-7.3	Low----------	0.32			
	21-54	18-35	1.55-1.70	0.6-2.0	0.13-0.19	5.1-7.8	Low----------	0.32			
	54-60	8-23	1.60-1.80	0.2-0.6	0.09-0.19	5.6-8.4	Low----------	0.32			
302B----------	0-10	7-13	1.50-1.60	0.6-2.0	0.16-0.24	4.5-7.3	Low----------	0.32	4	5	1-3
Rosholt	10-16	3-12	1.70-1.80	0.6-6.0	0.10-0.22	4.5-7.3	Low----------	0.24			
	16-23	6-15	1.65-1.75	0.6-6.0	0.09-0.19	4.5-7.3	Low----------	0.24			
	23-26	4-15	1.55-1.65	0.6-6.0	0.04-0.16	4.5-7.3	Low----------	0.10			
	26-60	0-5	1.50-1.80	>6.0	0.02-0.04	5.1-6.5	Low----------	0.10			
325----------	0-13	15-27	1.30-1.45	0.6-2.0	0.18-0.22	5.6-7.3	Low----------	0.28	5	6	4-8
Prebish	13-42	12-18	1.50-1.70	0.2-2.0	0.14-0.16	5.6-7.3	Low----------	0.28			
	42-60	2-15	1.65-1.90	0.2-0.6	0.09-0.13	5.6-8.4	Low----------	0.28			
328B, 328C-------	0-7	4-10	1.25-1.40	6.0-20	0.10-0.12	5.1-6.0	Low----------	0.15	5	2	.5-2
Sartell	7-39	0-5	1.50-1.65	6.0-20	0.06-0.10	5.1-6.0	Low----------	0.15			
	39-60	0-5	1.50-1.65	6.0-20	0.05-0.09	5.6-7.3	Low----------	0.15			
337----------	0-12	4-18	0.80-1.40	0.6-6.0	0.19-0.25	4.5-6.0	Low----------	0.24	4	5	7-20
Warman	12-33	4-18	1.20-1.45	0.6-2.0	0.15-0.20	5.1-7.3	Low----------	0.32			
	33-60	0-5	1.55-1.75	>6.0	0.01-0.08	6.1-7.3	Low----------	0.10			
341A, 341B-------	0-10	6-18	1.40-1.60	2.0-6.0	0.13-0.15	6.6-8.4	Low----------	0.20	3	3	1-4
Arvilla	10-18	6-18	1.40-1.60	2.0-6.0	0.11-0.14	6.6-8.4	Low----------	0.20			
	18-60	2-10	1.40-1.60	>6.0	0.02-0.05	7.4-8.4	Low----------	0.10			
375----------	0-16	10-22	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.8	Low----------	0.28	4	5	5-9
Forada	16-21	8-18	1.30-1.50	2.0-6.0	0.12-0.19	6.1-7.8	Low----------	0.28			
	21-60	0-5	1.50-1.70	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.15			
413----------	0-10	10-22	1.20-1.40	0.6-2.0	0.18-0.22	6.1-7.3	Low----------	0.28	3	5	2-4
Osakis	10-19	8-18	1.30-1.50	0.6-6.0	0.14-0.19	6.1-7.3	Low----------	0.28			
	19-60	0-5	1.50-1.70	>6.0	0.02-0.04	7.4-8.4	Low----------	0.10			
454B, 454C, 454E, 454F----------	0-5	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low----------	0.15	5	2	<1
Mahtomedi	5-35	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low----------	0.10			
	35-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low----------	0.10			
458A, 458B, 458C, 458E, 458F------	0-5	2-10	1.20-1.50	6.0-20	0.10-0.12	4.5-6.5	Low----------	0.15	5	2	.5-2
Menahga	5-60	0-5	1.50-1.65	6.0-20	0.05-0.07	5.6-7.3	Low----------	0.15			
540----------	0-12	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-8.4	----------	----	5	8	>25
Seelyeville	12-60	---	0.10-0.25	0.2-6.0	0.35-0.45	4.5-8.4	----------	----			
541----------	0-7	---	0.20-0.35	0.2-6.0	0.35-0.45	4.5-7.3	----------	----	5	8	>25
Rifle	7-60	---	0.08-0.20	0.6-6.0	0.45-0.55	4.5-7.3	----------	----			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
543	0-33	---	0.15-0.45	0.2-6.0	0.35-0.45	5.6-7.8			4	8	55-85
Markey	33-60	0-10	1.40-1.65	6.0-20	0.03-0.08	5.6-8.4	Low				
544	0-7	---	0.28-0.45	0.2-6.0	0.45-0.55	4.5-7.8			5	8	60-85
Cathro	7-25	---	0.15-0.30	0.2-6.0	0.35-0.45	4.5-7.8					
	25-60	10-25	1.50-1.70	0.2-2.0	0.11-0.22	6.6-8.4	Low				
549	0-12	---	0.30-0.40	>6.0	0.55-0.65	3.6-4.4			5	8	55-75
Greenwood	12-60	---	0.10-0.25	0.6-6.0	0.45-0.55	3.6-4.4					
623A, 623B	0-14	4-18	1.40-1.55	2.0-6.0	0.13-0.17	5.1-6.5	Low	0.20	4	3	1-3
Pierz	14-28	10-18	1.45-1.65	0.6-6.0	0.16-0.20	5.1-6.5	Low	0.28			
	28-60	0-5	1.55-1.65	>6.0	0.02-0.04	5.1-6.5	Low	0.10			
835*:											
Brainerd	0-6	8-18	1.40-1.60	2.0-6.0	0.13-0.18	4.5-6.0	Low	0.28	4	3	.5-4
	6-18	5-15	1.45-1.70	2.0-6.0	0.12-0.16	4.5-6.0	Low	0.28			
	18-46	8-18	1.45-1.80	0.6-2.0	0.12-0.16	5.1-6.5	Low	0.28			
	46-60	---	---	---	---	---					
Rock outcrop.											
928B*, 928C*, 928E*, 928F*:											
Cushing	0-5	6-14	1.35-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low	0.24	5	3	1-2
	5-19	4-16	1.55-1.65	0.6-2.0	0.10-0.22	5.1-7.8	Low	0.32			
	19-42	18-35	1.55-1.70	0.6-2.0	0.10-0.19	5.1-7.8	Low	0.32			
	42-60	8-21	1.45-1.80	0.2-0.6	0.09-0.19	5.1-8.4	Low	0.32			
Mahtomedi	0-5	2-15	1.40-1.60	6.0-20	0.10-0.12	5.1-6.5	Low	0.15	5	2	<1
	5-38	0-10	1.45-1.70	6.0-20	0.05-0.07	5.1-6.5	Low	0.10			
	38-60	0-10	1.45-1.75	6.0-20	0.04-0.09	5.1-7.8	Low	0.10			
DeMontreville	0-6	2-6	1.50-1.68	6.0-20	0.10-0.12	5.6-7.3	Low	0.17	5	2	.5-1
	6-33	1-6	1.55-1.75	6.0-20	0.06-0.09	5.6-7.3	Low	0.17			
	33-46	6-22	1.70-1.80	0.2-0.6	0.08-0.14	5.6-6.5	Low	0.28			
	46-60	5-10	1.75-1.85	0.2-0.6	0.06-0.10	5.6-7.3	Low	0.28			
1015.											
Psamments											
1016.											
Udorthents											
1030*:											
Pits.											
Udorthents.											
1934	0-4	---	0.15-0.30	0.2-6.0	0.35-0.45	5.6-8.4			5	8	40-90
Bowstring	4-8	1-12	1.40-1.60	0.6-20	0.08-0.14	5.6-8.4	Low	0.15			
	8-41	---	0.15-0.30	0.2-6.0	0.35-0.45	5.6-8.4					
	41-60	1-12	1.40-1.60	0.6-20	0.08-0.14	5.6-8.4	Low	0.15			
1946*:											
Fordum	0-8	10-23	1.35-1.45	0.6-2.0	0.17-0.24	5.6-8.4	Low	0.28	4	8	4-12
	8-50	8-18	1.40-1.50	0.6-6.0	0.10-0.22	5.6-8.4	Low	0.43			
	50-60	2-5	1.55-1.70	>6.0	0.04-0.10	5.6-8.4	Low	0.15			
Winterfield	0-4	0-15	0.90-1.50	2.0-6.0	0.10-0.12	5.6-7.8	Low	0.17	5	2	1-3
	4-29	0-15	1.45-1.60	6.0-20	0.06-0.11	5.6-7.8	Low	0.17			
	29-60	0-10	1.55-1.65	6.0-20	0.04-0.10	5.6-8.4	Low	0.17			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
1973*:											
Meehan	0-7	4-10	1.35-1.65	6.0-20	0.10-0.12	3.6-6.5	Low	0.17	5	2	.5-3
	7-28	4-9	1.60-1.70	6.0-20	0.06-0.11	5.1-7.3	Low	0.17			
	28-60	1-4	1.60-1.70	6.0-20	0.02-0.07	5.1-7.3	Low	0.17			
Isan	0-13	5-14	1.30-1.55	6.0-20	0.10-0.15	5.6-7.3	Low	0.17	5	3	3-10
	13-25	2-8	1.50-1.65	6.0-20	0.06-0.10	5.1-6.5	Low	0.17			
	25-60	1-5	1.55-1.70	6.0-20	0.04-0.06	5.6-7.3	Low	0.17			
1976B	0-4	8-18	1.40-1.60	2.0-6.0	0.13-0.18	4.5-6.0	Low	0.20	4	8	.5-4
Brainerd	4-14	5-15	1.45-1.70	2.0-6.0	0.12-0.16	4.5-6.0	Low	0.28			
	14-26	8-18	1.45-1.80	0.6-2.0	0.12-0.16	5.1-6.5	Low	0.28			
	26-33	4-18	1.75-1.90	0.06-0.2	0.03-0.08	5.1-7.3	Low	0.28			
	33-60	4-18	1.80-2.00	<0.2	0.-0.04	5.6-7.3	Low	0.28			
1977B	0-4	6-18	1.30-1.60	2.0-6.0	0.14-0.16	5.1-6.5	Low	0.20	4	8	.5-3
Mora	4-15	6-18	1.30-1.60	0.6-6.0	0.14-0.20	5.1-6.5	Low	0.28			
	15-32	8-18	1.50-1.70	0.6-2.0	0.15-0.19	5.6-6.5	Low	0.28			
	32-49	4-18	1.70-1.90	0.06-0.2	0.03-0.08	5.6-6.5	Low	0.28			
	49-60	4-18	1.80-2.00	<0.2	0.01-0.04	5.6-7.8	Low	0.28			
1978	0-5	6-18	1.30-1.50	0.6-2.0	0.18-0.22	4.5-5.5	Low	0.24	4	8	3-8
Nokay	5-17	5-15	1.45-1.70	0.6-6.0	0.12-0.19	4.5-5.5	Low	0.28			
	17-30	8-18	1.45-1.80	0.6-2.0	0.12-0.19	5.1-6.5	Low	0.28			
	30-40	4-18	1.75-1.90	0.06-0.2	0.03-0.08	5.6-7.3	Low	0.28			
	40-60	4-18	1.80-2.00	<0.2	0.-0.04	5.6-7.3	Low	0.28			
1979	0-6	12-27	1.30-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	4	8	4-7
Parent	6-33	5-18	1.50-1.65	0.6-2.0	0.12-0.17	5.6-7.3	Low	0.28			
	33-42	5-18	1.75-1.90	0.06-0.2	0.03-0.08	6.1-8.4	Low	0.28			
	42-60	5-18	1.90-2.00	<0.2	0.-0.04	6.1-8.4	Low	0.28			
1980	0-4	5-18	1.30-1.60	0.6-2.0	0.18-0.23	5.1-6.5	Low	0.24	4	8	1-4
Ronneby	4-11	5-18	1.30-1.60	0.6-6.0	0.12-0.19	5.1-6.5	Low	0.28			
	11-28	6-18	1.45-1.75	0.6-2.0	0.12-0.19	5.6-6.5	Low	0.28			
	28-38	4-18	1.70-1.90	0.06-0.2	0.03-0.08	6.1-7.3	Low	0.28			
	38-60	4-18	1.80-2.00	<0.2	0.-0.04	6.1-8.4	Low	0.28			
1998	0-10	28-40	1.20-1.30	0.06-0.6	0.18-0.22	6.6-7.3	High	0.24	5	4	5-10
Warman Variant	10-14	30-50	1.20-1.35	0.06-0.6	0.14-0.22	6.6-7.3	High	0.24			
	14-31	35-60	1.20-1.35	0.06-0.6	0.13-0.16	7.4-8.4	High	0.24			
	31-60	30-50	1.20-1.40	0.2-0.6	0.16-0.19	7.4-8.4	High	0.24			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
7A, 7B---------- Hubbard	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
12C, 12D---------- Emmert	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
25---------- Becker	B	Rare--------	---	---	4.0-6.0	Apparent	Nov-May	---	Moderate	Low------	Low.
119B, 119C-------- Pomroy	C	None--------	---	---	>6.0	---	---	---	Low------	Moderate	Low.
142---------- Nokay	C	None--------	---	---	1.0-3.0	Perched	Apr-Jun	---	High-----	Moderate	High.
144B, 144C, 144E-- Flak	C	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
152B, 152C-------- Milaca	C	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
155B, 155C-------- Chetek	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	High.
158B---------- Zimmerman	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	High.
161---------- Isanti	A/D	None--------	---	---	0-2.0	Apparent	Oct-Jun	---	Moderate	High-----	Moderate.
163B---------- Brainerd	C	None--------	---	---	1.5-2.5	Perched	Apr-Jun	---	Moderate	Moderate	Moderate.
164B---------- Mora	C	None--------	---	---	2.0-3.0	Perched	Mar-Jun	---	High-----	Moderate	Moderate.
165---------- Parent	B/D	None--------	---	---	0.5-2.5	Perched	Mar-Jul	---	High-----	High-----	Moderate.
166---------- Ronneby	C	None--------	---	---	1.5-3.0	Perched	Oct-Jun	---	High-----	Moderate	Moderate.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
182A, 182B-------- Oesterle	C	None--------	---	---	1.0-3.0	Apparent	Oct-May	---	High-----	Low------	Moderate.
200B, 200C-------- Holdingford	C	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
202--------------- Meehan	B	None--------	---	---	1.0-3.0	Apparent	Oct-May	---	Moderate	Low------	Moderate.
204B, 204C, 204E-- Cushing	B	None--------	---	---	>6.0	---	---	---	Moderate	Moderate	Moderate.
217--------------- Nokasippi	B/D	None--------	---	---	+1-2.0	Apparent	Jan-Dec	---	High-----	High-----	Moderate.
218--------------- Watab	C	None--------	---	---	1.5-3.0	Perched	Mar-Jun	---	Moderate	Moderate	Moderate.
233A-------------- Growton	B	None--------	---	---	1.0-3.0	Apparent	Apr-Jun	---	High-----	Low------	Moderate.
233B-------------- Growton	B	None--------	---	---	3.0-5.0	Apparent	Apr-Jun	---	High-----	Low------	Moderate.
260--------------- Duelm	A	None--------	---	---	2.0-5.0	Apparent	Mar-Jun	---	Moderate	Low------	Moderate.
261--------------- Isan	A/D	None--------	---	---	+.5-2.0	Apparent	Oct-Jun	---	Moderate	High-----	Moderate.
264B-------------- Freeon	B	None--------	---	---	2.0-3.0	Perched	Nov-May	---	Moderate	Low------	Moderate.
265--------------- Soderville	A	None--------	---	---	2.0-4.0	Apparent	Nov-Jun	---	Moderate	Low------	Moderate.
266--------------- Freer	C	None--------	---	---	1.0-3.0	Perched	Nov-Jun	---	High-----	High-----	Moderate.
292--------------- Alstad	C	None--------	---	---	1.0-3.0	Perched	Nov-May	---	High-----	Moderate	Moderate.
302B-------------- Rosholt	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
325--------------- Prebish	C/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	---	High-----	High-----	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
328B, 328C-------- Sartell	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
337--------------- Warman	B/D	None--------	---	---	+2-1.0	Apparent	Jan-Dec	---	High-----	High-----	High.
341A, 341B-------- Arvilla	B	None--------	---	---	>6.0	---	---	---	Low------	Moderate	Low.
375--------------- Forada	B/D	None--------	---	---	1.0-3.0	Apparent	Oct-Jun	---	High-----	High-----	Low.
413--------------- Osakis	B	None--------	---	---	3.0-6.0	Apparent	Nov-Jun	---	Moderate	Low------	Low.
454B, 454C, 454E, 454F------------- Mahtomedi	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	High.
458A, 458B, 458C, 458E, 458F------- Menahga	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
540--------------- Seelyeville	A/D	None--------	---	---	+2-2.0	Apparent	Jan-Dec	50-55	High-----	High-----	Moderate.
541--------------- Rifle	A/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	19-22	High-----	High-----	Low.
543--------------- Markey	A/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	25-30	High-----	High-----	Low.
544--------------- Cathro	A/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	19-22	High-----	High-----	Low.
549--------------- Greenwood	A/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	19-22	High-----	High-----	High.
623A, 623B-------- Pierz	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
835*: Brainerd--------- Rock outcrop.	C	None--------	---	---	1.5-2.5	Perched	Apr-Jun	---	Moderate	Moderate	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
928B*, 928C*, 928E*, 928F*:											
Cushing	B	None	---	---	>6.0	---	---	---	Moderate	Moderate	Moderate.
Mahtomedi	A	None	---	---	>6.0	---	---	---	Low	Low	High.
DeMontreville	B	None	---	---	>6.0	---	---	---	Low	Low	Moderate.
1015. Psamments											
1016. Udorthents											
1030*: Pits.											
Udorthents.											
1934 Bowstring	A/D	Frequent	Long	Mar-Jun	0-2.0	Apparent	Oct-Jun	20-30	High	High	Low.
1946*:											
Fordum	D	Frequent	Brief to long.	Mar-Jun	+1-1.0	Apparent	Jan-Dec	---	High	High	High.
Winterfield	A/D	Frequent	Brief	Jan-Dec	0.5-1.5	Apparent	Jan-Dec	---	Moderate	Low	Low.
1973*:											
Meehan	B	None	---	---	1.0-3.0	Apparent	Oct-May	---	Moderate	Low	Moderate.
Isan	A/D	None	---	---	+.5-2.0	Apparent	Oct-Jun	---	Moderate	High	Moderate.
1976B Brainerd	C	None	---	---	1.5-2.5	Perched	Apr-Jun	---	Moderate	Moderate	Moderate.
1977B Mora	C	None	---	---	2.0-3.0	Perched	Mar-Jun	---	High	Moderate	Moderate.
1978 Nokay	C	None	---	---	1.0-3.0	Perched	Apr-Jun	---	High	Moderate	High.
1979 Parent	B/D	None	---	---	0.5-2.5	Perched	Mar-Jul	---	High	High	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
1980-------------- Ronneby	C	None---------	---	---	1.5-3.0	Perched	Oct-Jun	---	High-----	Moderate	Moderate.
1998-------------- Warman Variant	D	None---------	---	---	+2-1.0	Apparent	Mar-Jun	---	High-----	High-----	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Alstad	Fine-loamy, mixed Aquic Eutroboralfs
Arvilla	Sandy, mixed Udic Haploborolls
*Becker	Coarse-loamy, mixed, mesic Typic Hapludolls
*Bowstring	Euic Fluvaquentic Borosaprists
Brainerd	Coarse-loamy, mixed Aquic Eutroboralfs
Cathro	Loamy, mixed, euic Terric Borosaprists
Chetek	Coarse-loamy, mixed Eutric Glossoboralfs
Cushing	Fine-loamy, mixed Glossic Eutroboralfs
DeMontreville	Loamy, mixed Arenic Eutroboralfs
Duelm	Sandy, mixed Aquic Haploborolls
Emmert	Sandy-skeletal, mixed, frigid Typic Udorthents
Flak	Coarse-loamy, mixed Typic Eutroboralfs
*Forada	Coarse-loamy, mixed, frigid Typic Haplaquolls
Fordum	Coarse-loamy, mixed, nonacid, frigid Mollic Fluvaquents
Freeon	Coarse-loamy, mixed Typic Glossoboralfs
Freer	Fine-loamy, mixed, frigid Aeric Glossaqualfs
Greenwood	Dysic Typic Borohemists
Growton	Coarse-loamy, mixed Aquic Eutroboralfs
Holdingford	Coarse-loamy, mixed Mollic Eutroboralfs
Hubbard	Sandy, mixed Udorthentic Haploborolls
Isan	Sandy, mixed, frigid Typic Haplaquolls
Isanti	Sandy, mixed, frigid Typic Haplaquolls
Mahtomedi	Mixed, frigid Typic Udipsamments
Markey	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
Meehan	Mixed, frigid Aquic Udipsamments
Menahga	Mixed, frigid Typic Udipsamments
Milaca	Coarse-loamy, mixed Typic Eutroboralfs
Mora	Coarse-loamy, mixed Aquic Eutroboralfs
Nokasippi	Coarse-loamy, mixed, frigid Typic Haplaquolls
Nokay	Coarse-loamy, mixed, frigid Udollic Ochraqualfs
Oesterle	Coarse-loamy, mixed Aquic Glossoboralfs
*Osakis	Sandy, mixed Aquic Haploborolls
Parent	Coarse-loamy, mixed, frigid Typic Haplaquolls
Pierz	Coarse-loamy, mixed Udic Argiborolls
Pomroy	Loamy, mixed Arenic Eutroboralfs
Prebish	Coarse-loamy, mixed, frigid Typic Haplaquolls
Psamments	Mixed, frigid Udipsamments
Rifle	Euic Typic Borohemists
Ronneby	Coarse-loamy, mixed, frigid Udollic Ochraqualfs
*Rosholt	Coarse-loamy, mixed Typic Glossoboralfs
Sartell	Mixed, frigid Typic Udipsamments
Seelyeville	Euic Typic Borosaprists
*Soderville	Sandy, mixed Aquic Glossoboralfs
Udorthents	Loamy, mixed, frigid Udorthents (map unit 1016); sandy and loamy, mixed, frigid Udorthents (map unit 1030)
Warman	Coarse-loamy over sandy or sandy-skeletal, mixed, frigid Typic Haplaquolls
Warman Variant	Fine, montmorillonitic, frigid Typic Haplaquolls
Watab	Coarse-loamy, mixed Aquic Eutroboralfs
Winterfield	Mixed, frigid Aquic Udipsamments
Zimmerman	Mixed, frigid Alfic Udipsamments

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Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND*

- 1 HUBBARD-DUELM-ISAN association
- 2 MAHTOMEDI-MENAHGA association
- 3 PIERZ-ARVILLA association
- 4 CHETEK-MAHTOMEDI-OESTERLE association
- 5 POMROY association
- 6 MORA-RONNEBY-FREER association
- 7 BRAINERD-NOKAY-PREBISH association
- 8 CUSHING-MAHTOMEDI-DEMONTREVILLE association
- 9 GROWTON-HOLDINGFORD-PARENT association
- 10 SEELYEVILLE-GREENWOOD-BRAINERD association

*The units on this legend are described in the text under the heading "General Soil Map Units."

Compiled 1986

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MINNESOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

MORRISON COUNTY, MINNESOTA

Scale 1:253,440

1 0 1 2 3 4 Mi

1 0 4 8 Km

Inset A, sheet 3

Inset B, sheet 3

Inset, sheet 8

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

N

INDEX TO MAP SHEETS

MORRISON COUNTY, MINNESOTA

Scale 1:253,440

1 0 1 2 3 4 Mi

1 0 4 8 Km

SOIL LEGEND

Map symbols consist of numbers and a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas.

SYMBOL	NAME
7A	Hubbard loamy sand, 0 to 2 percent slopes
7B	Hubbard loamy sand, 2 to 6 percent slopes
12C	Emmert gravelly loamy sand, 6 to 12 percent slopes
12D	Emmert gravelly loamy sand, 12 to 40 percent slopes
25	Becker fine sandy loam
119B	Pomroy loamy fine sand, 1 to 6 percent slopes
119C	Pomroy loamy fine sand, 6 to 12 percent slopes
142	Nokay loam
144B	Flak sandy loam, 4 to 8 percent slopes
144C	Flak sandy loam, 8 to 15 percent slopes
144E	Flak sandy loam, 15 to 25 percent slopes
152B	Milaca fine sandy loam, 4 to 8 percent slopes
152C	Milaca fine sandy loam, 8 to 15 percent slopes
155B	Chetek sandy loam, 2 to 8 percent slopes
155C	Chetek sandy loam, 8 to 15 percent slopes
158B	Zimmerman loamy fine sand, 1 to 4 percent slopes
161	Isanti fine sandy loam
163B	Brainerd sandy loam, 1 to 4 percent slopes
164B	Mora fine sandy loam, 1 to 4 percent slopes
165	Parent loam
166	Ronneby loam
182A	Oesterle sandy loam, 0 to 1 percent slopes
182B	Oesterle sandy loam, 1 to 3 percent slopes
200B	Holdingford sandy loam, 4 to 8 percent slopes
200C	Holdingford sandy loam, 8 to 15 percent slopes
202	Meehan loamy sand
204B	Cushing fine sandy loam, 4 to 8 percent slopes
204C	Cushing fine sandy loam, 8 to 15 percent slopes
204E	Cushing fine sandy loam, 15 to 25 percent slopes
217	Nokasippi mucky loamy fine sand
218	Watab loamy fine sand
233A	Growton sandy loam, 0 to 2 percent slopes
233B	Growton sandy loam, 2 to 4 percent slopes
260	Duelm loamy sand
261	Isan sandy loam
264B	Freeon silt loam, 1 to 4 percent slopes
265	Soderville loamy fine sand
266	Freer silt loam
292	Alstad loam
302B	Rosholt silt loam, 1 to 4 percent slopes
325	Prebish loam
328B	Sartell loamy fine sand, 1 to 6 percent slopes
328C	Sartell loamy fine sand, 6 to 12 percent slopes
337	Warman loam
341A	Arvilla sandy loam, 0 to 2 percent slopes
341B	Arvilla sandy loam, 2 to 6 percent slopes
375	Forada loam
413	Osakis loam
454B	Mahtomedi loamy sand, 2 to 8 percent slopes
454C	Mahtomedi loamy sand, 8 to 15 percent slopes
454E	Mahtomedi loamy sand, 15 to 25 percent slopes
454F	Mahtomedi loamy sand, 25 to 45 percent slopes
458A	Menahga loamy sand, 0 to 2 percent slopes
458B	Menahga loamy sand, 2 to 8 percent slopes
458C	Menahga loamy sand, 8 to 15 percent slopes
458E	Menahga loamy sand, 15 to 25 percent slopes
458F	Menahga loamy sand, 25 to 45 percent slopes
540	Seelyeville muck
541	Rifle muck
543	Markey muck
544	Cathro muck
549	Greenwood peat
623A	Pierz sandy loam, 0 to 2 percent slopes
623B	Pierz sandy loam, 2 to 6 percent slopes
835	Brainerd-Rock outcrop complex
928B	Cushing-Mahtomedi-DeMontreville complex, 2 to 8 percent slopes
928C	Cushing-Mahtomedi-DeMontreville complex, 8 to 15 percent slopes
928E	Cushing-Mahtomedi-DeMontreville complex, 15 to 25 percent slopes
928F	Cushing-Mahtomedi-DeMontreville complex, 25 to 45 percent slopes
1015	Psamments, nearly level
1016	Udorthents, loamy
1030	Pits, gravel-Udorthents complex
1934	Bowstring muck
1946	Fordum-Winterfield complex
1973	Meehan-Isan complex
1976B	Brainerd sandy loam, 1 to 4 percent slopes, extremely stony
1977B	Mora fine sandy loam, 1 to 4 percent slopes, extremely stony
1978	Nokay loam, extremely stony
1979	Parent loam, extremely stony
1980	Ronneby loam, extremely stony
1998	Warman Variant silty clay loam

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

County or parish

Reservation (national forest or park, state forest or park, and large airport)

Field sheet matchline & neatline

AD HOC BOUNDARY (label)

Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

350 000 FEET

LAND DIVISION CORNERS (sections and land grants)

ROAD EMBLEMS & DESIGNATIONS

Federal

State

RAILROAD

DAMS

Medium or small

PITS

Gravel pit

Mine or quarry

WATER FEATURES

DRAINAGE

Perennial, double line

Perennial, single line

Intermittent

Drainage end

Canals or ditches

Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

Perennial

MISCELLANEOUS WATER FEATURES

Marsh or swamp

Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

MISCELLANEOUS

Gravelly spot

Rock outcrop (includes sandstone and shale)

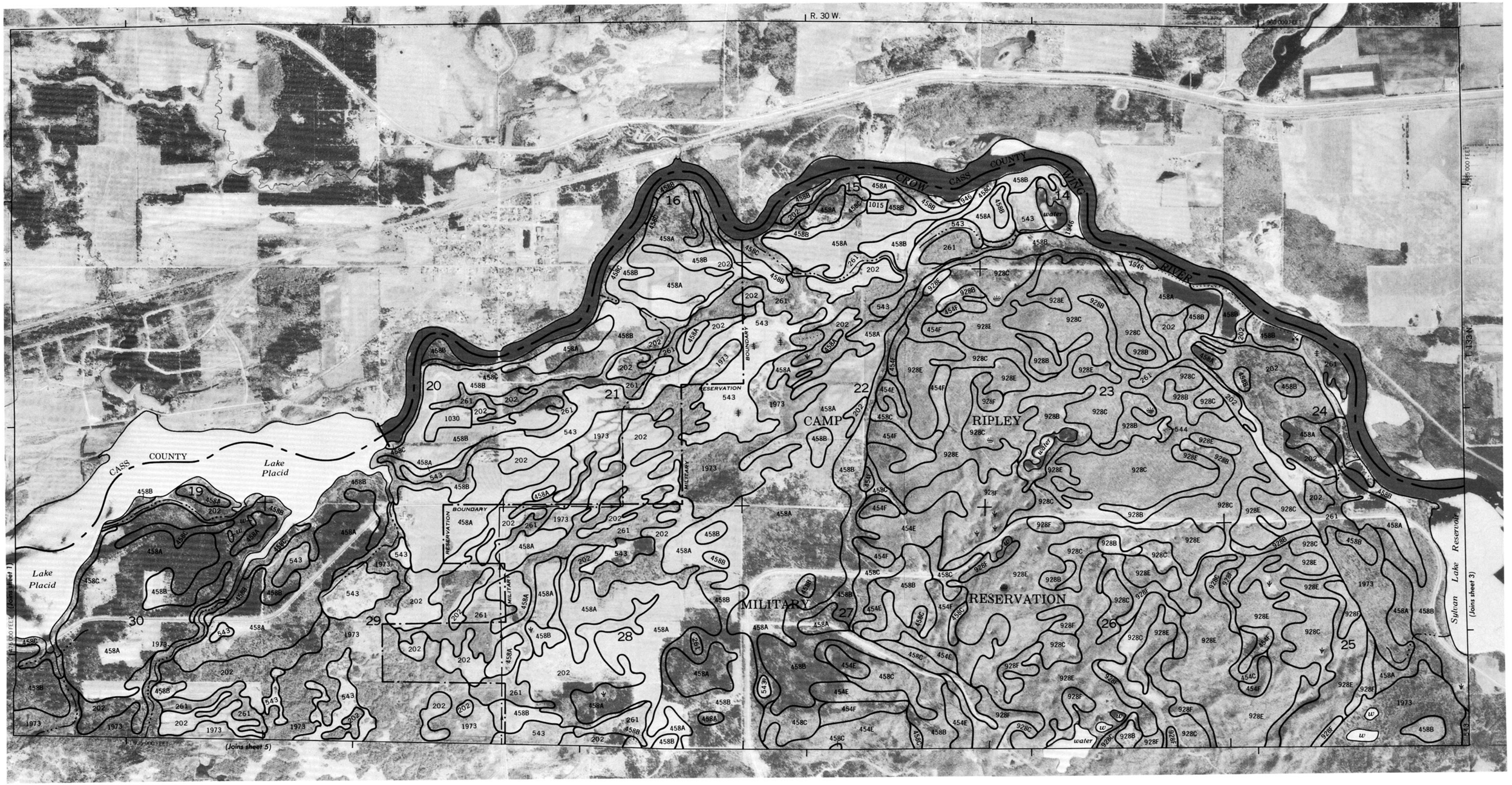
Sandy spot

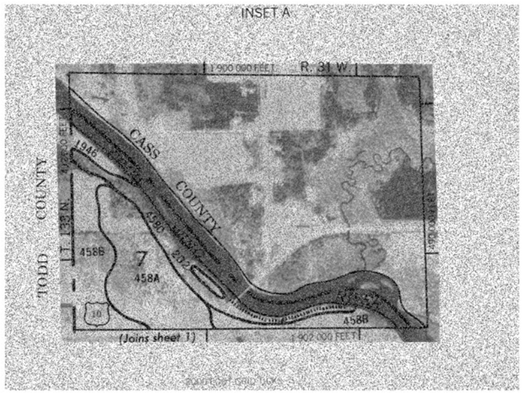
Stony spot, very stony spot

Better drained soil in poorly drained area

Reduced reliability
No access

MORRISON COUNTY, MINNESOTA — SHEET NUMBER 1

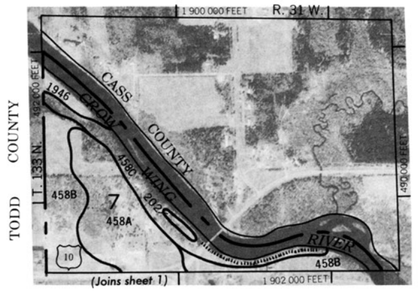

2
N
R. 30 W.
935 000 FEET
T. 133 N.
CROW
CASS
COUNTY
WING
RIVER
CASS COUNTY
Lake Placid
Lake Placid
CAMP RIPLEY
MILITARY RESERVATION
RESERVATION BOUNDARY
MILITARY BOUNDARY
Sylvan Lake Reservoir
water
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 5)



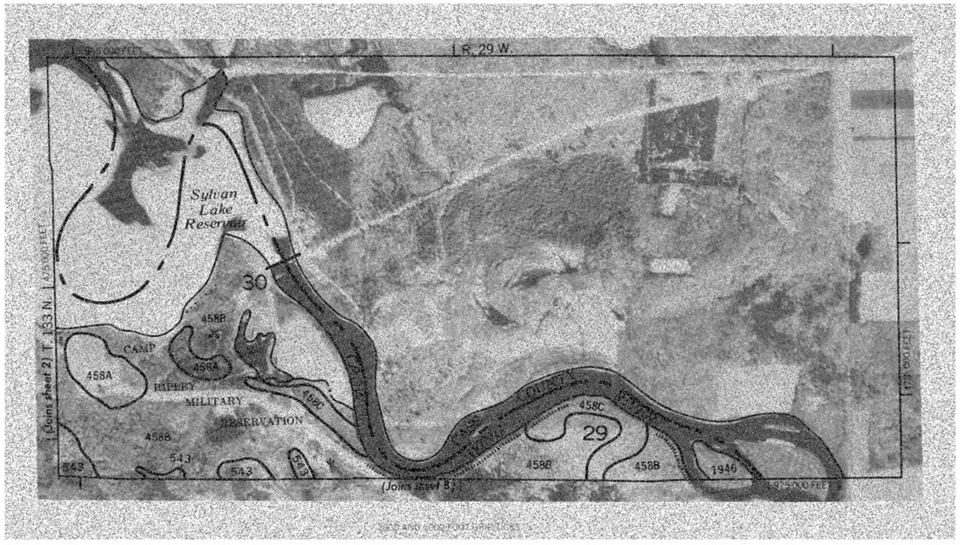
2000 AND 5000-FOOT GRID TICKS

3
N

INSET A



2000-FOOT GRID TICKS



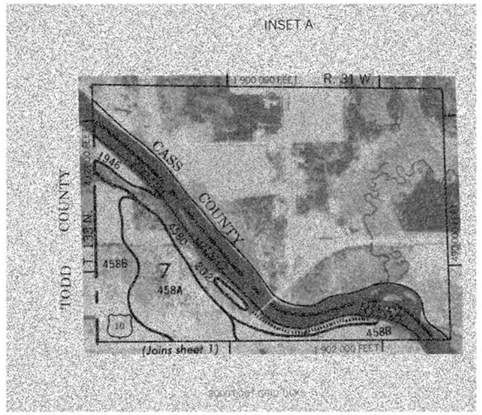
2000 AND 6000-FOOT GRID TICKS

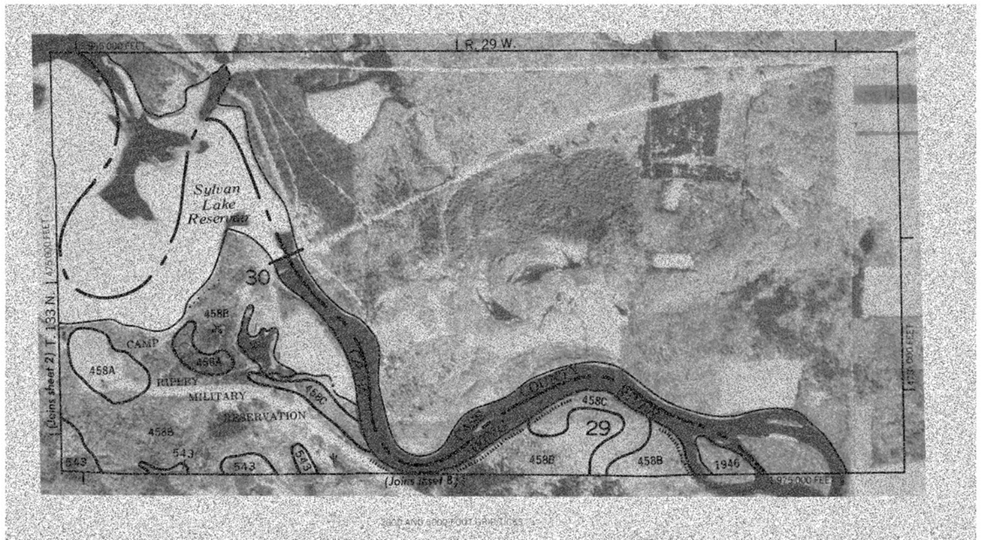
INSET B

3

N

INSET A

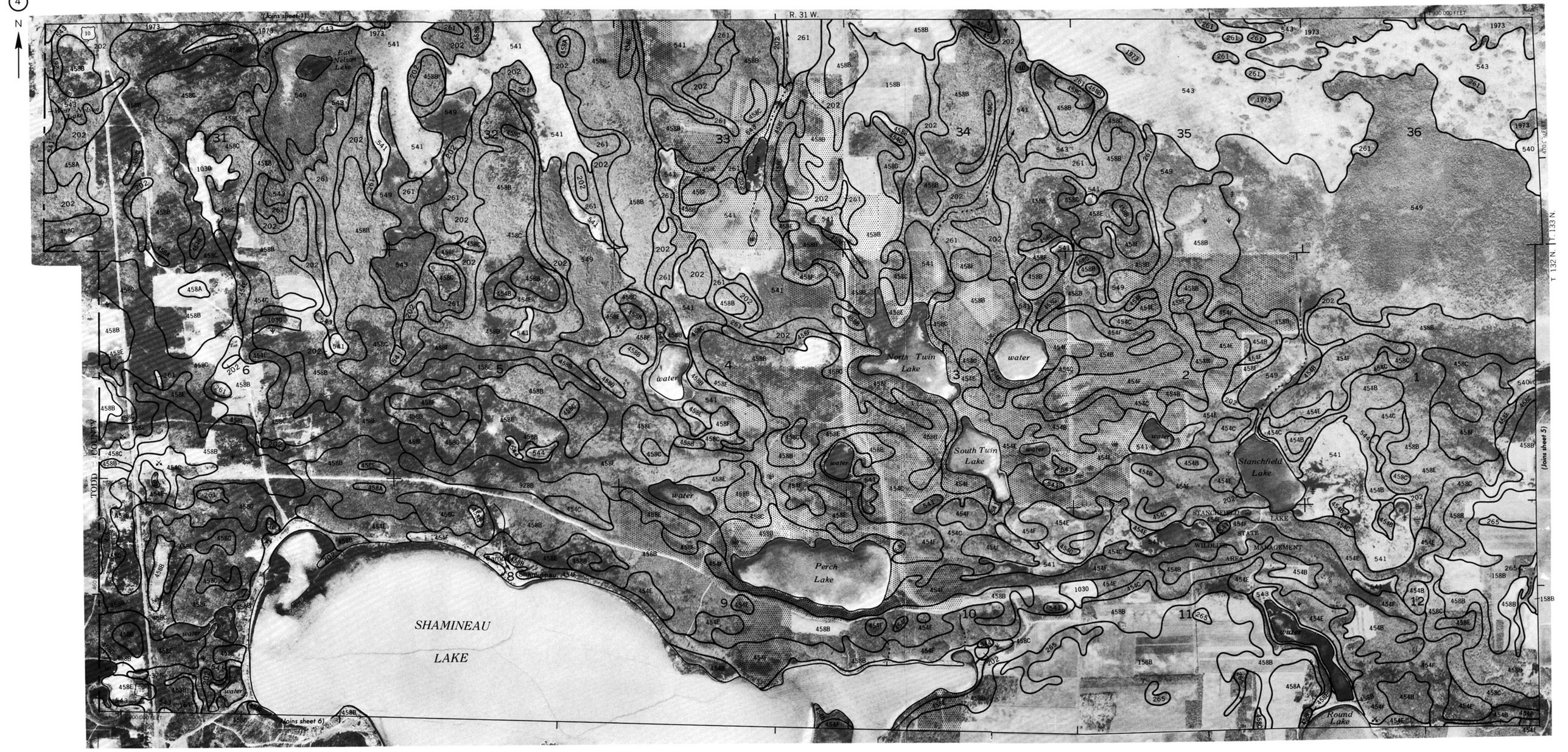


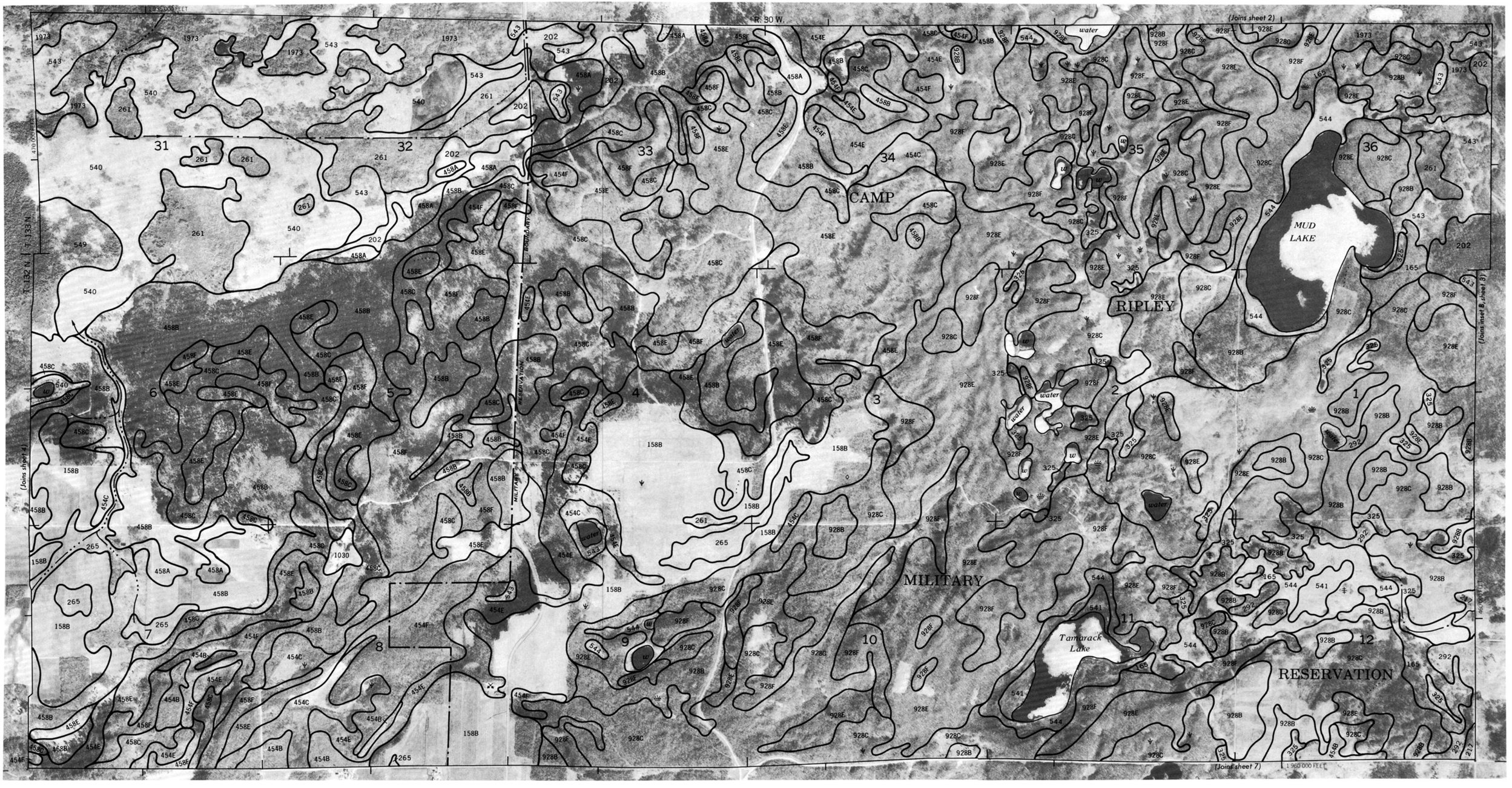


INSET B

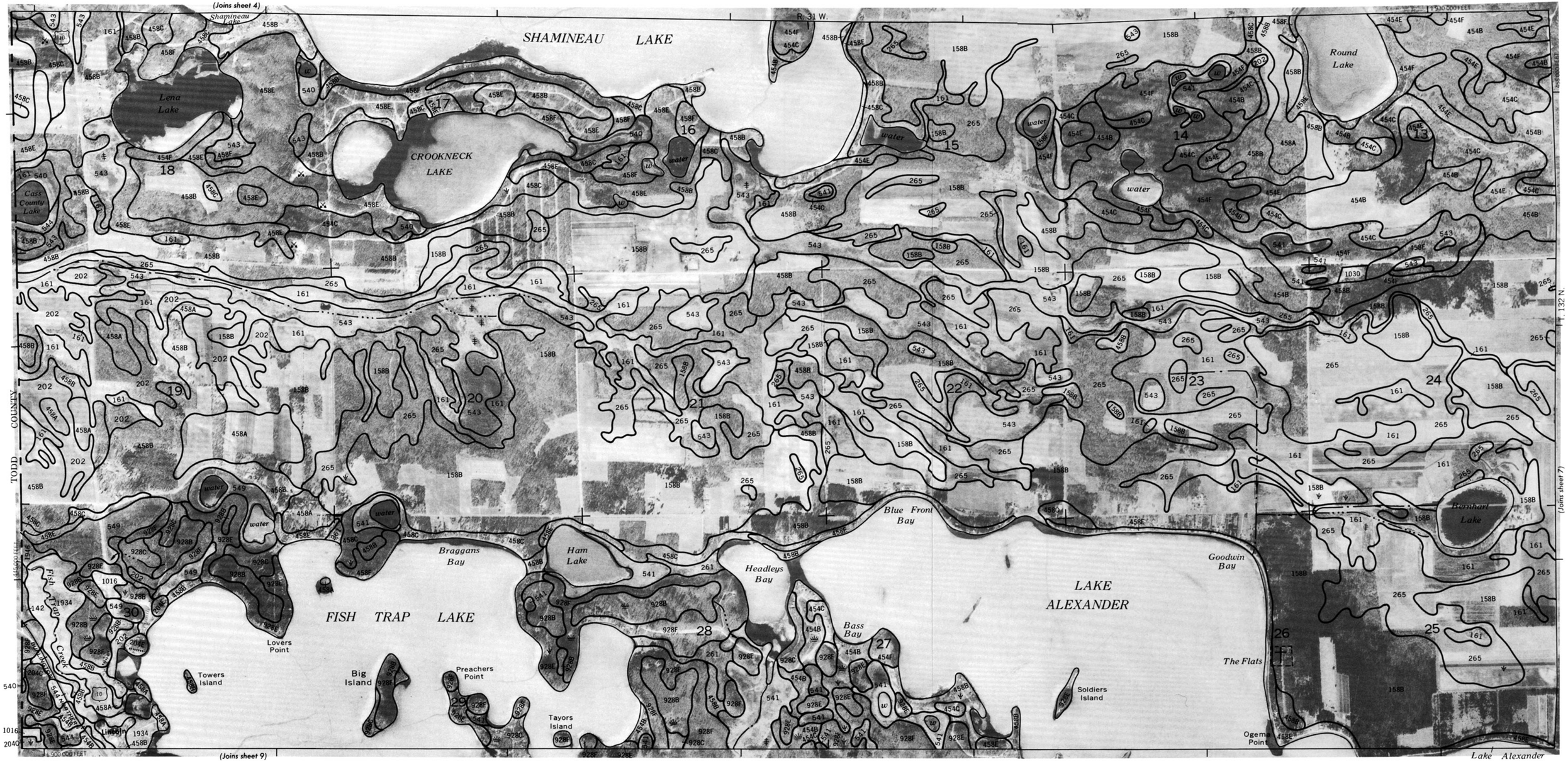
3

N


4
N
(Joins sheet 1)
R. 31 W.
T 132 N.
T 133 N.
(Joins sheet 5)
(Joins sheet 6)
TODD COUNTY
East Nelson Lake
West Nelson Lake
North Twin Lake
South Twin Lake
Stanchfield Lake
STANCHFIELD LAKE STATE WILDLIFE MANAGEMENT AREA
Perch Lake
SHAMINEAU LAKE
Shamineau
Round Lake
water
31
32
33
34
35
36
1
2
3
4
5
6
7
8
9
10
11
12


R. 30 W.
T. 133 N.
T. 132 N.
1 935 000 FEET
470 000 FEET
(Joins sheet 2)
(Joins sheet 4)
(Joins inset B, sheet 3)
(Joins sheet 7)
1 960 000 FEET
460 000 FEET
CAMP
RIPLEY
MILITARY
RESERVATION
MUD LAKE
Tamarack Lake
BOUNDARY
RESERVATION
MILITARY
water
31
32
33
34
35
36
1
2
3
4
5
6
7
8
9
10
11
12

5
N


6
N
(Joins sheet 4)
Shamineau Lake
SHAMINEAU LAKE
R. 31 W.
Lena Lake
CROOKNECK LAKE
Cass County Lake
Round Lake
water
TODD COUNTY
T. 132 N.
(Joins sheet 7)
Blue Front Bay
Braggans Bay
Ham Lake
Headleys Bay
Goodwin Bay
Bernhart Lake
LAKE ALEXANDER
FISH TRAP LAKE
Fish Trap Creek
Bass Bay
The Flats
Lovers Point
Towers Island
Big Island
Preachers Point
Tayors Island
Soldiers Island
Ogema Point
Lake Alexander
(Joins sheet 9)


R. 30 W.
T. 132 N.
CAMP
RIPLEY
MILITARY
RESERVATION
BOUNDARY
RESERVATION
MILITARY
BOUNDARY
MILITARY
Fosdick Lake
Frog Lake
Bass Lake
Coon Stump Lake
Cockburn Lake
Lake Ericson
Long Lake
Mud Lake
Lake Alexander
Still Lake
Deer Lake
MISSISSIPPI RIVER
CROW WING COUNTY
water
(Joins sheet 5)
(Joins sheet 6)
(Joins sheet 8)
(Joins sheet 10)
1 938 000 FEET
1 960 000 FEET
945 000 FEET
N

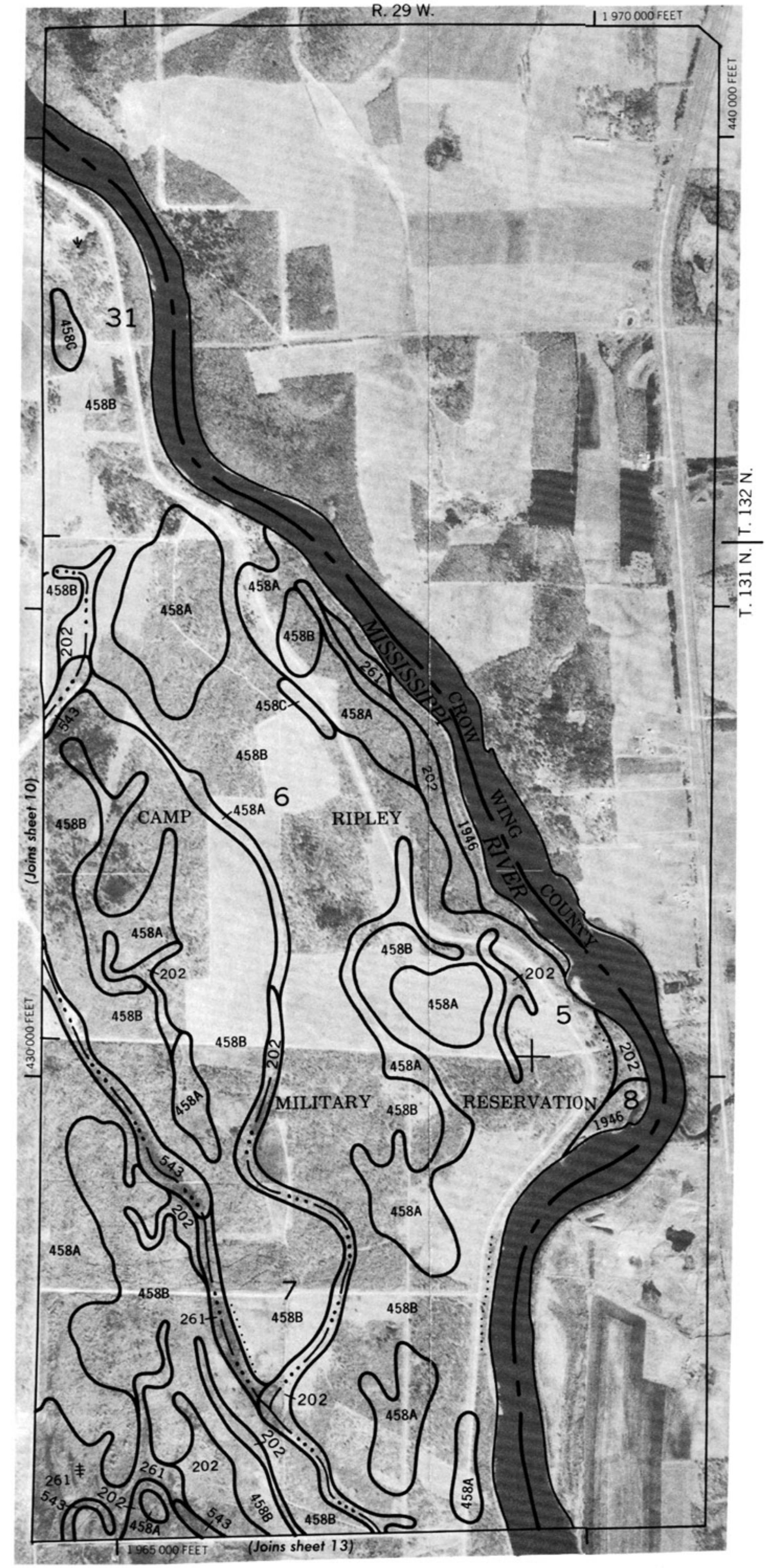

8
N
(Joins inset B, sheet 3)
R. 29 W.
1 970 000 FEET
455 000 FEET
T. 132 N.
(Joins sheet 7)
CAMP
RIPLEY
MILITARY
RESERVATION
MISSISSIPPI
CROW
WING
RIVER
COUNTY
17
18
19
458B
458C
458E
458A
454F
454E
217
202
261
1946
543
1 965 000 FEET

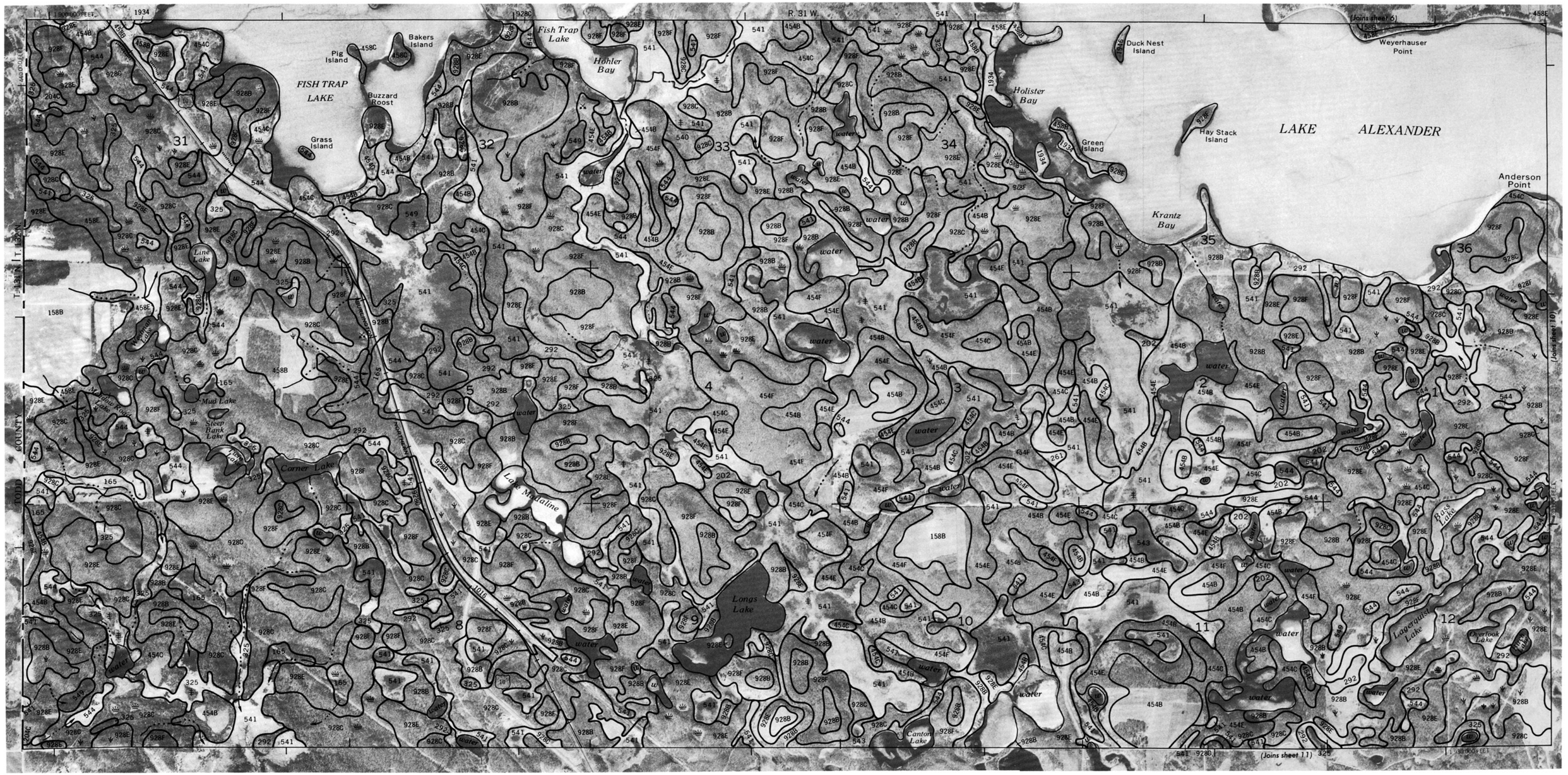

R. 29 W.
1 970 000 FEET
T. 131 N.
(Joins sheet 10)
(Joins sheet 13)
1 965 000 FEET
CAMP
RIPLEY
MILITARY
RESERVATION
31
6
5
8
7
458B
458A
458C
202
261
543
1946

8

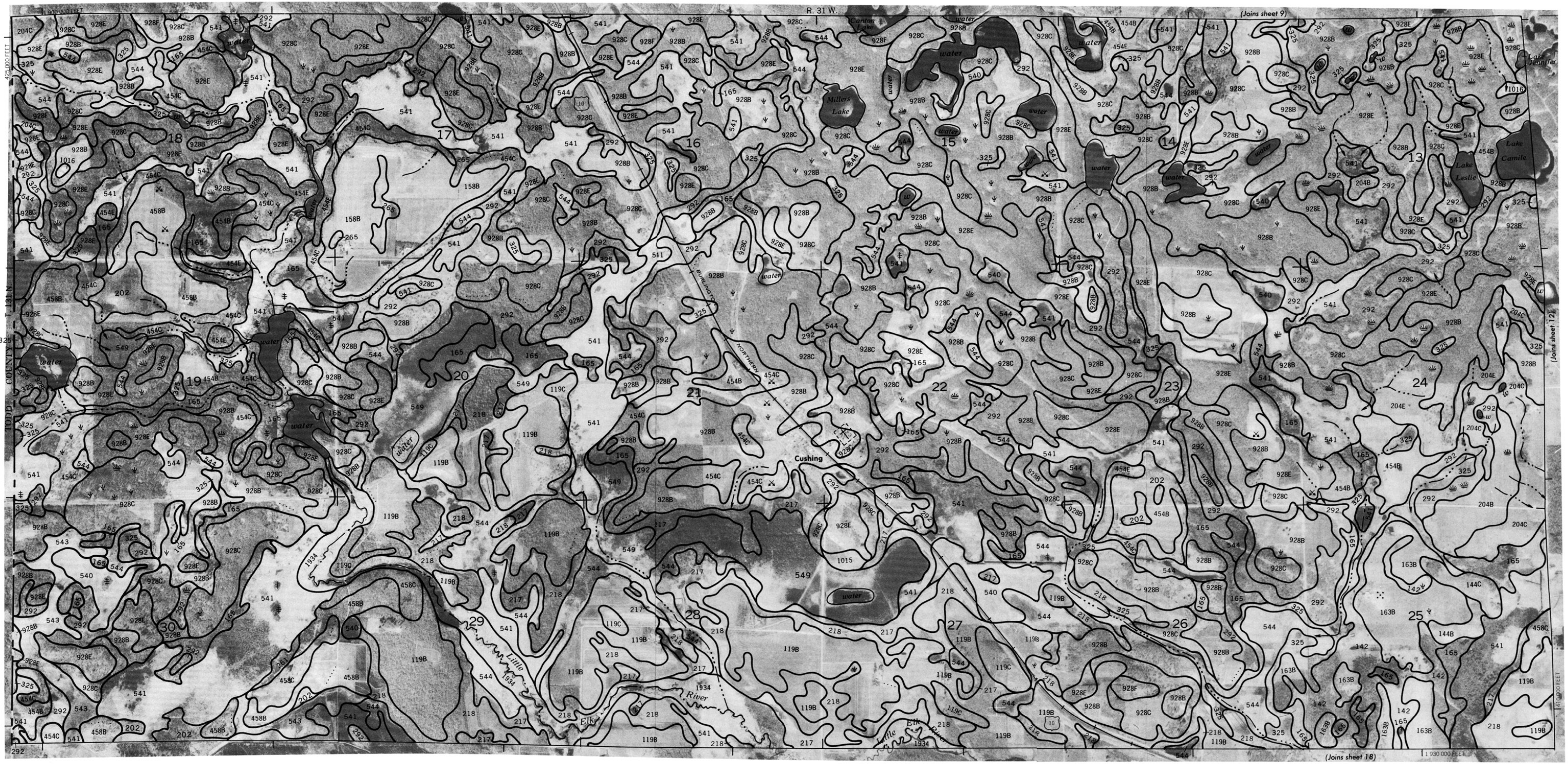
N

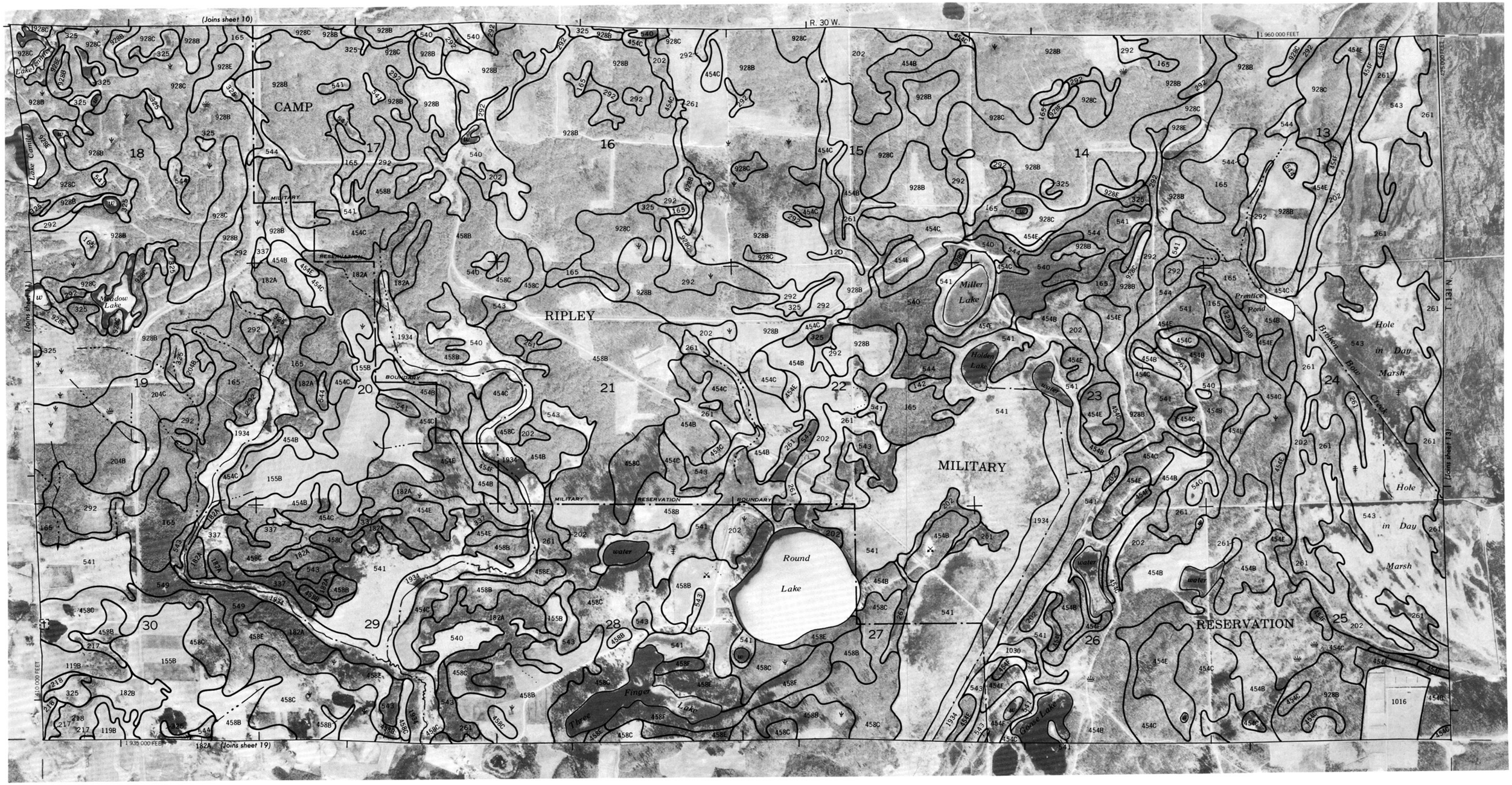

R. 29 W.
CAMP
RIPLEY
MILITARY
RESERVATION
17
18
19
T. 132 N.
(Joins sheet 7)

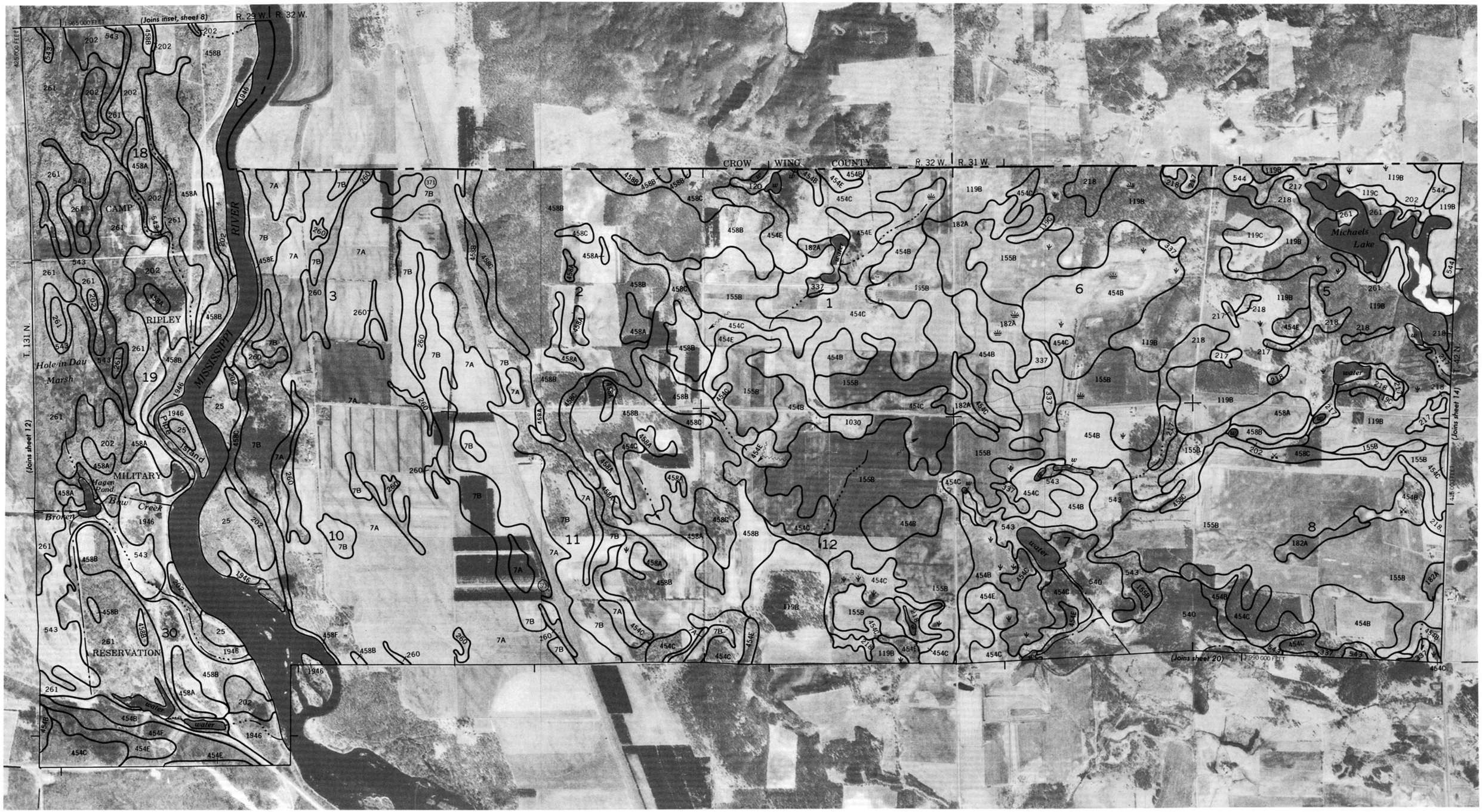

R. 29 W.
1 970 000 FEET
440 000 FEET
T. 132 N.
T. 131 N.
31
6
5
7
8
CAMP
RIPLEY
MILITARY
RESERVATION
MISSISSIPPI
RIVER
CROW
WING
COUNTY
(Joins sheet 10)
430 000 FEET
1 965 000 FEET
(Joins sheet 13)


R. 31 W.
T. 132 N.
T. 131 N.
TODD COUNTY
FISH TRAP LAKE
Fish Trap Lake
Hohler Bay
Holister Bay
Duck Nest Island
Weyerhauser Point
Pig Island
Bakers Island
Buzzard Roost
Grass Island
Hay Stack Island
LAKE ALEXANDER
Green Island
Anderson Point
Krantz Bay
Line Lake
Mud Lake
Sleep Bank Lake
Corner Lake
Lake Medaline
Longs Lake
Canton Lake
Bass Lake
Lagerquist Lake
Overlook Lake
(Joins sheet 6)
(Joins sheet 10)
(Joins sheet 11)
N

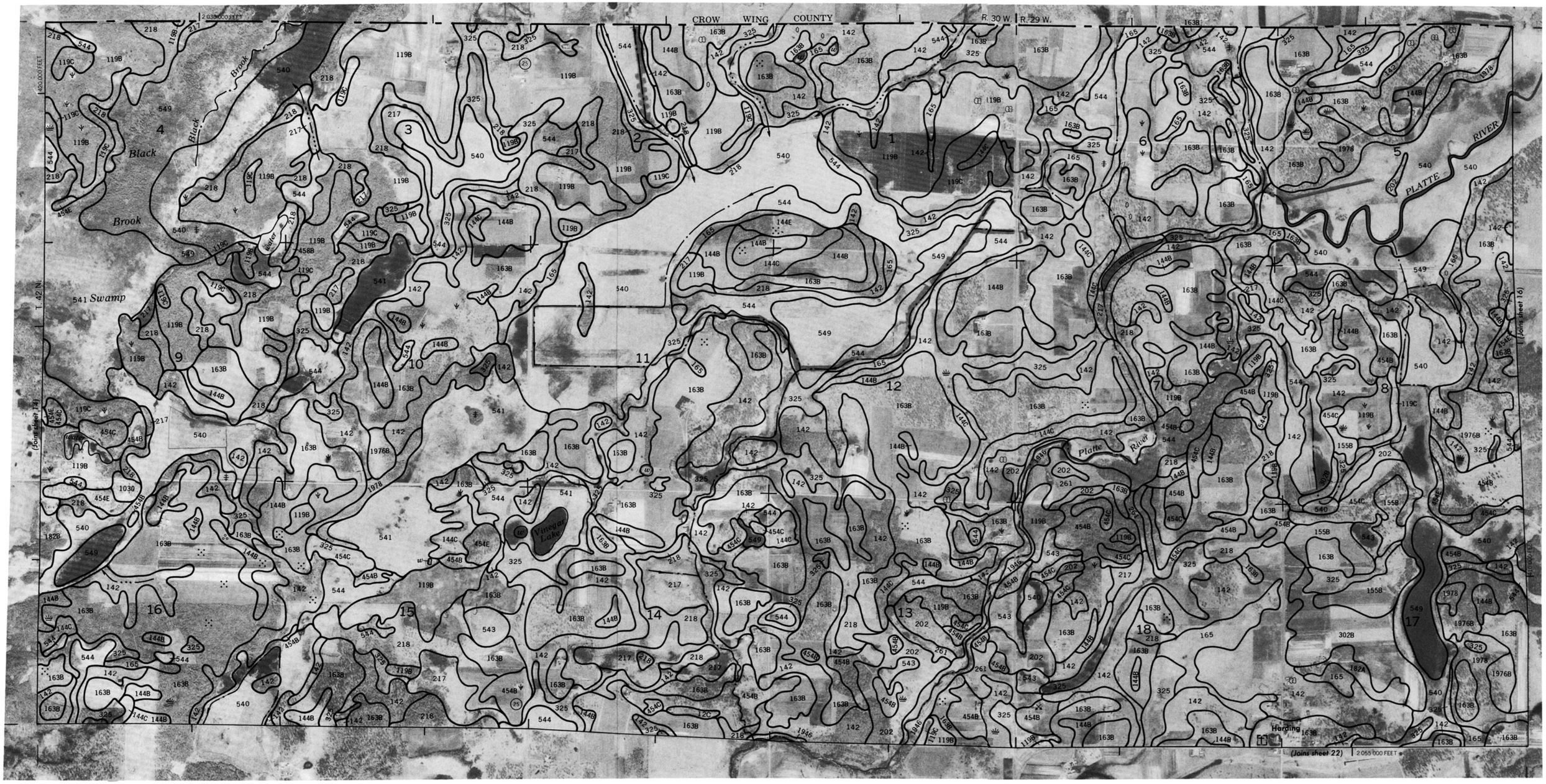

10
N
R. 30 W.
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 12)
(Joins sheet 8)
T. 132 N.
T. 131 N.
1 960 000 FEET
1 935 000 FEET
LAKE ALEXANDER
East End Bay
Anderson Bay
Mohrs Point
Still Lake
Quick Lake
Lake Alott
Mud Lake
Muskrat Lake
Mallard Lake
Sheep Lake
Pugh Lake
Johnson Lake
Miller
Water
CAMP RIPLEY MILITARY RESERVATION
MILITARY RESERVATION BOUNDARY
BOUNDARY
MISSISSIPPI R.
CROW WING R.
1 MILE
1 KILOMETER

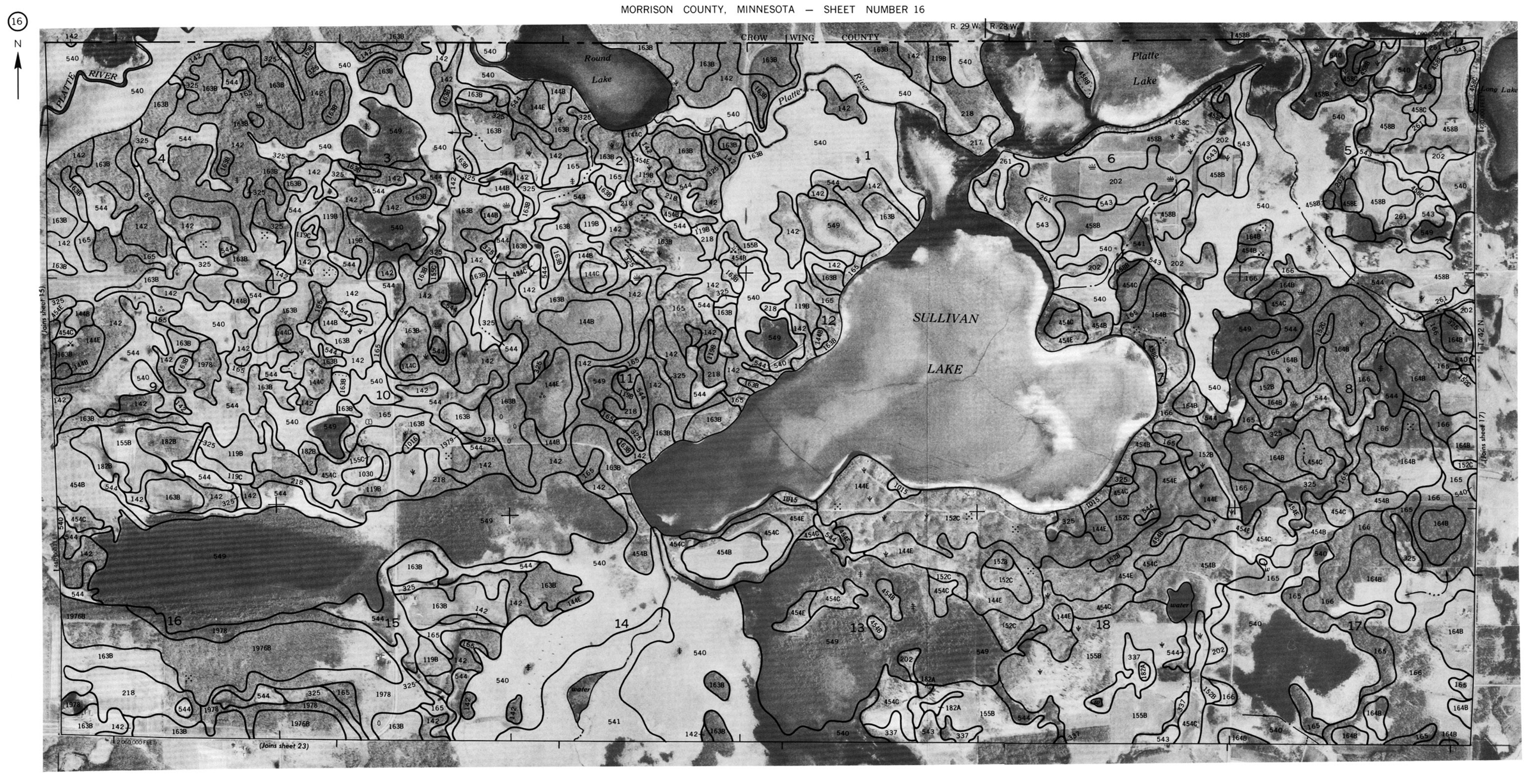

11
N
R. 31 W.
(Joins sheet 9)
(Joins sheet 18)
(Joins sheet 12)
T. 131 N.
TODD COUNTY
Cushing
Millers Lake
Carlton Lake
Lake Leslie
Lake Camile
BURLINGTON
NORTHERN
Little Elk River
water

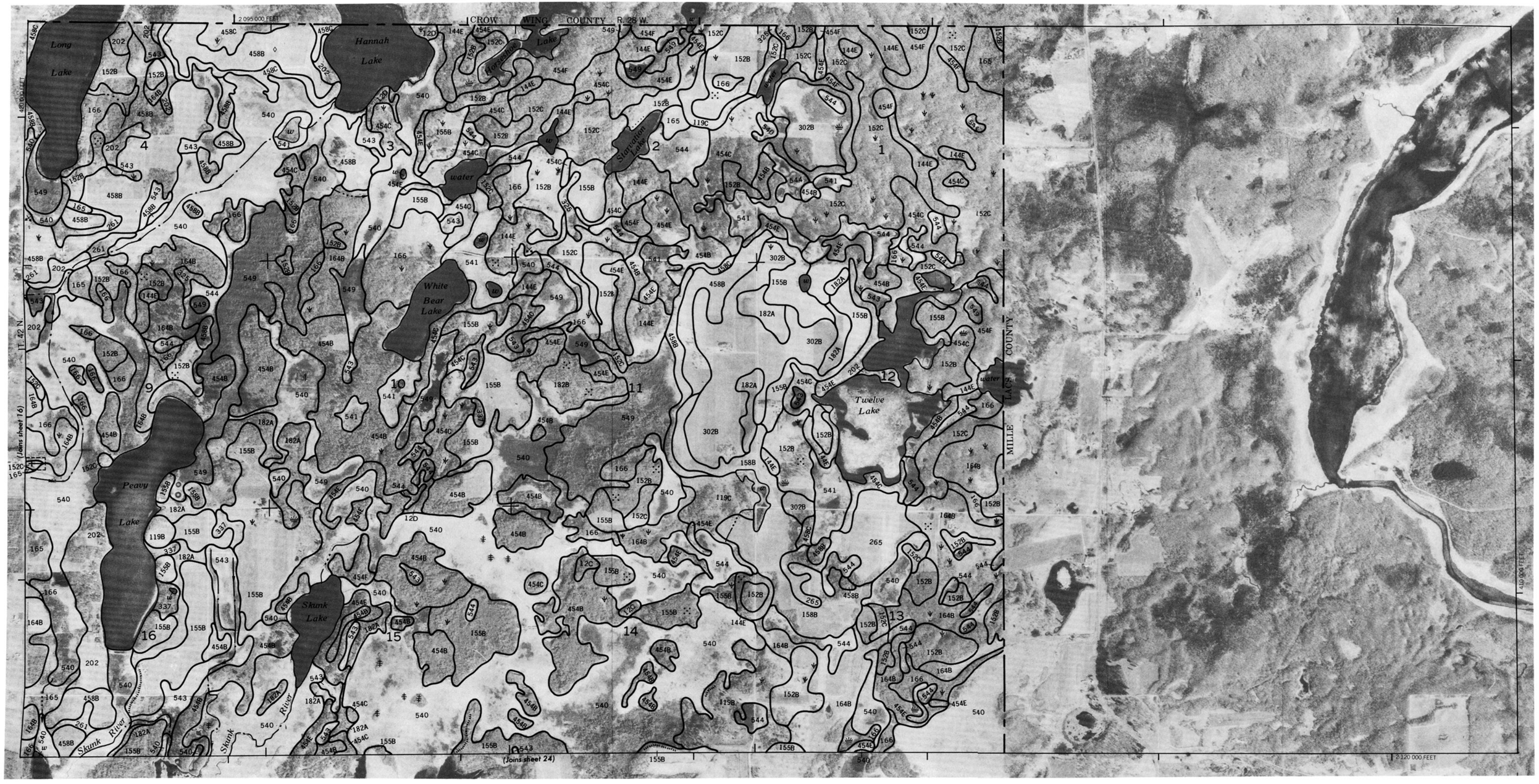

12
N
(Joins sheet 10)
R. 30 W.
1 960 000 FEET
CAMP
RIPLEY
MILITARY
RESERVATION
MILITARY RESERVATION BOUNDARY
Lake Camille
Meadow Lake
Miller Lake
Holden Lake
Prentice Pond
Broken Bow Creek
Hole in Day Marsh
Round Lake
Finger Three Lake
Goose Lake
water
T. 131 N.
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 19)
1 935 000 FEET
10 000 FEET


(Joins inset, sheet 8)
R. 29 W.
R. 32 W.
CROW WING COUNTY
R. 32 W.
R. 31 W.
T. 131 N.
T. 42 N.
(Joins sheet 12)
(Joins sheet 14)
(Joins sheet 20)
1 965 000 FEET
2 990 000 FEET
428 000 FEET
MISSISSIPPI RIVER
CAMP RIPLEY MILITARY RESERVATION
Hole in Day Marsh
Hagen Pond
Haw Creek
Broken
Pine Island
Michaels Lake
water
N


14
N
CROW WING COUNTY
R. 31 W.
R. 30 W.
T. 42 N.
Michaels Lake
Black Brook Swamp
RIPLEY ESKER
water
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 20)
(Joins sheet 21)

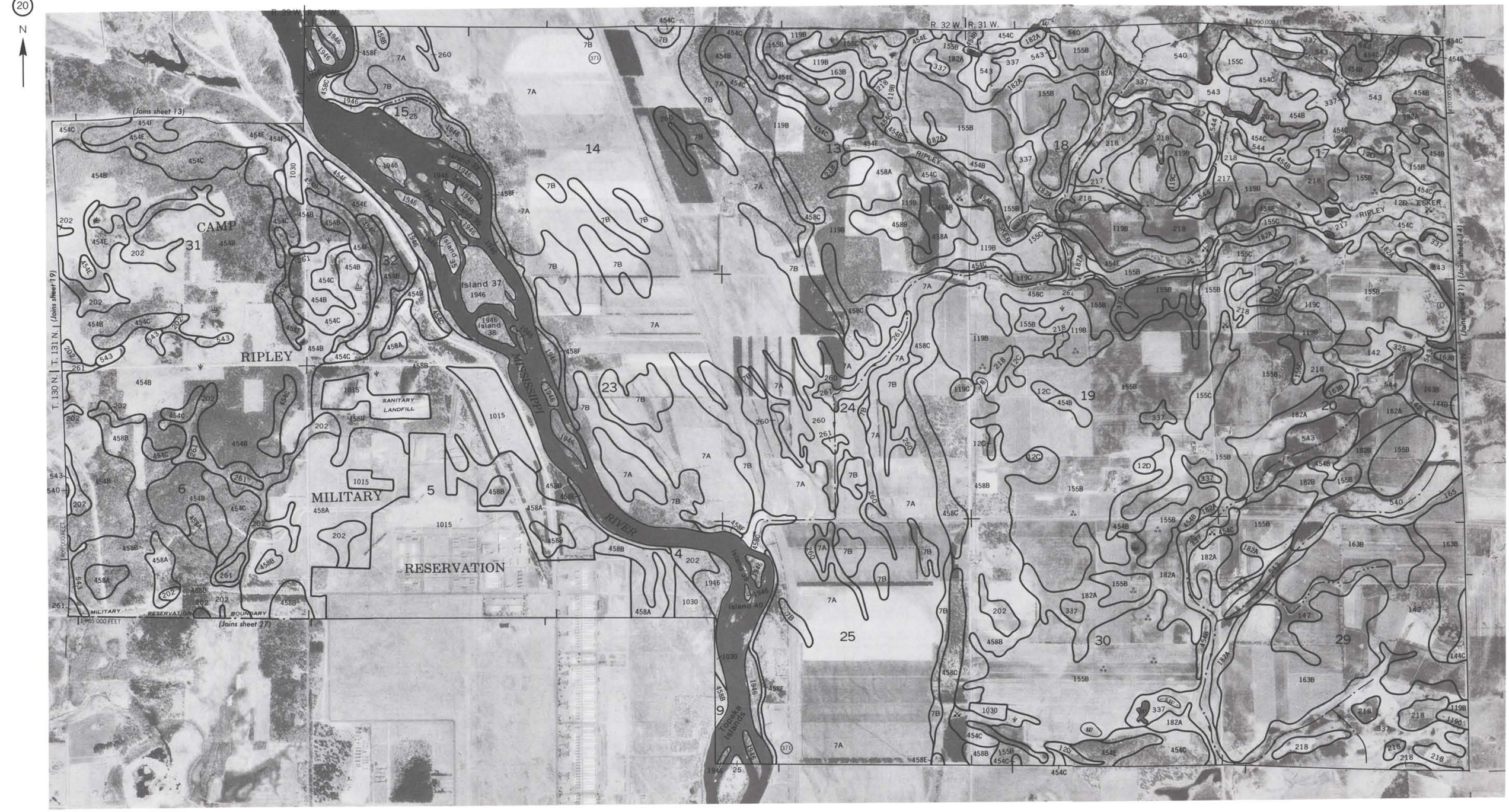

CROW WING COUNTY
R. 30 W.
R. 29 W.
T. 42 N.
2 035 000 FEET
2 055 000 FEET
4 200 000 FEET
Black Brook
Black Brook
Black Brook
Black Brook
Platte River
Platte River
541 Swamp
Vinegar Lake
Harding
(Joins sheet 14)
(Joins sheet 16)
(Joins sheet 22)
N

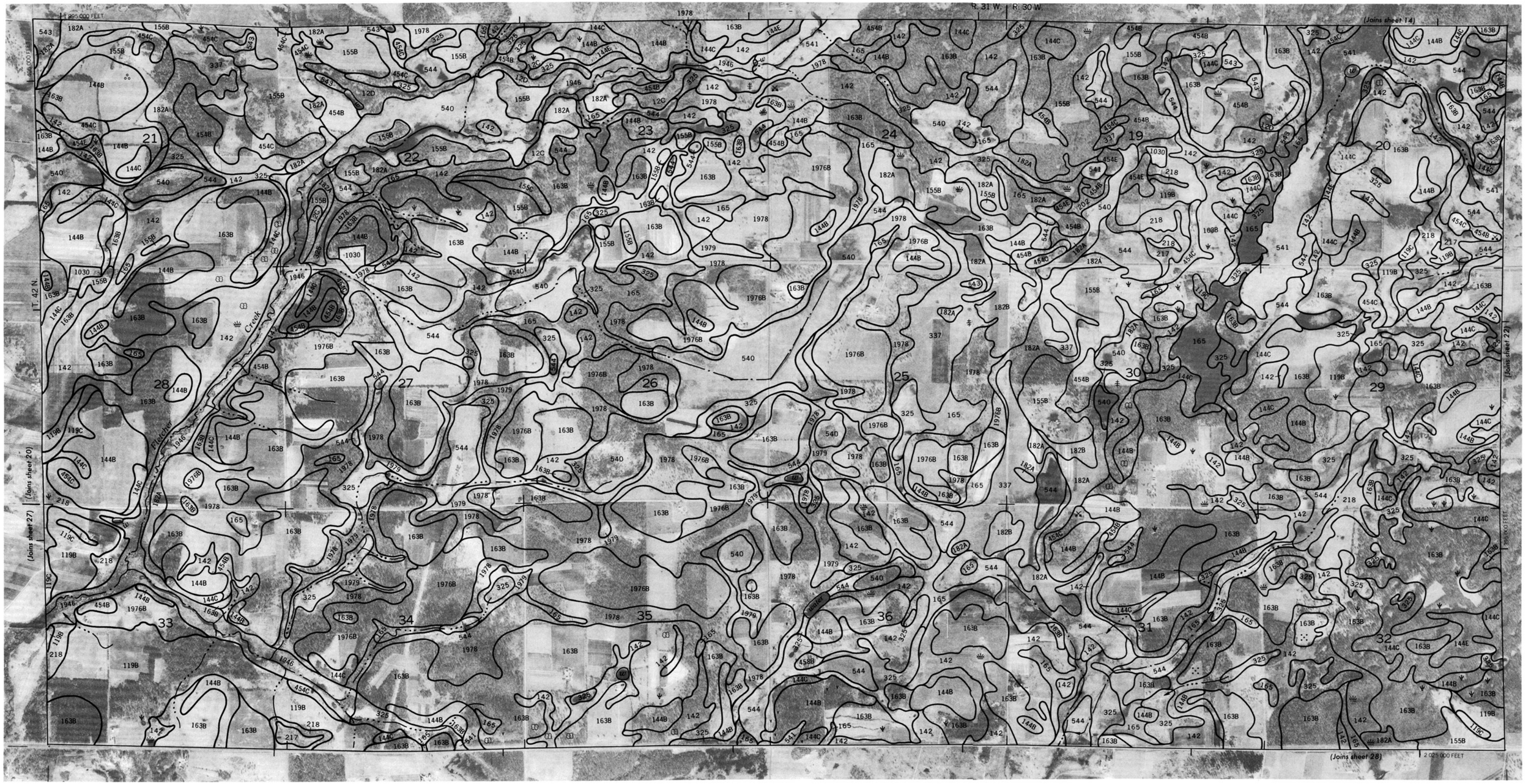

16
N
CROW WING COUNTY
R. 29 W.
R. 28 W.
T. 42 N.
PLATTE RIVER
Round Lake
Platte River
Platte Lake
Long Lake
SULLIVAN LAKE
water
water
(Joins sheet 15)
(Joins sheet 17)
(Joins sheet 23)
2060000 FEET
1458000 FEET


2 095 000 FEET
CROW WING COUNTY R. 28 W.
Long Lake
Hannah Lake
Horseshoe Lake
Starvation Lake
water
White Bear Lake
Peavy Lake
Skunk Lake
Twelve Lake
water
MILLE LACS COUNTY
T. 42 N.
(Joins sheet 16)
(Joins sheet 24)
Skunk River
Skunk River
2 120 000 FEET
410 000 FEET
480 000 FEET
N


18
N
(Joins sheet 11)
R. 31 W.
1 930 000 FEET
T. 130 N.
(Joins sheet 25)
Little Elk River
South Branch Little Elk River
BURLINGTON NORTHERN
water
31
32
33
34
35
36
1
2
3
4
5
6
7
8
9
10
11
12


N
R. 30 W.
T. 130 N.
T. 131 N.
1 935 000 FEET
405 000 FEET
395 000 FEET
1 960 000 FEET
(Joins sheet 12)
(Joins sheet 18)
(Joins sheet 19)
(Joins sheet 20)
(Joins sheet 26)
Goose Lake
CAMP
Ferrell Lake
RIPLEY
Dale Lake
Johnson Lake
Kraft Lake
MILITARY
RESERVATION
BOUNDARY
NEITERMEIER
STATE
WILDLIFE
MANAGEMENT
AREA
Randall
Hay Creek
Little Elk River
South Branch
Little Elk River
Elk River
NORTHERN PACIFIC
water


20
N
R. 29 W.
R. 32 W.
R. 31 W.
T. 130 N.
T. 131 N.
T. 142 N.
(Joins sheet 13)
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 14)
(Joins sheet 27)
CAMP
RIPLEY
MILITARY
RESERVATION
SANITARY LANDFILL
MISSISSIPPI RIVER
Island 37
1946
Island 38
Island 39
Island 40
Topeka Islands
ESKER
MILITARY RESERVATION BOUNDARY
1,965,000 FEET
1,990,000 FEET
810,000 FEET
800,000 FEET


R. 31 W.
R. 30 W.
T. 42 N.
1 995 000 FEET
2 025 000 FEET
405 000 FEET
395 000 FEET
(Joins sheet 14)
(Joins sheet 20)
(Joins sheet 21)
(Joins sheet 27)
(Joins sheet 28)
Creek
Fletcher
Creek
21
22
23
24
19
20
28
27
26
25
30
29
33
34
35
36
31
32

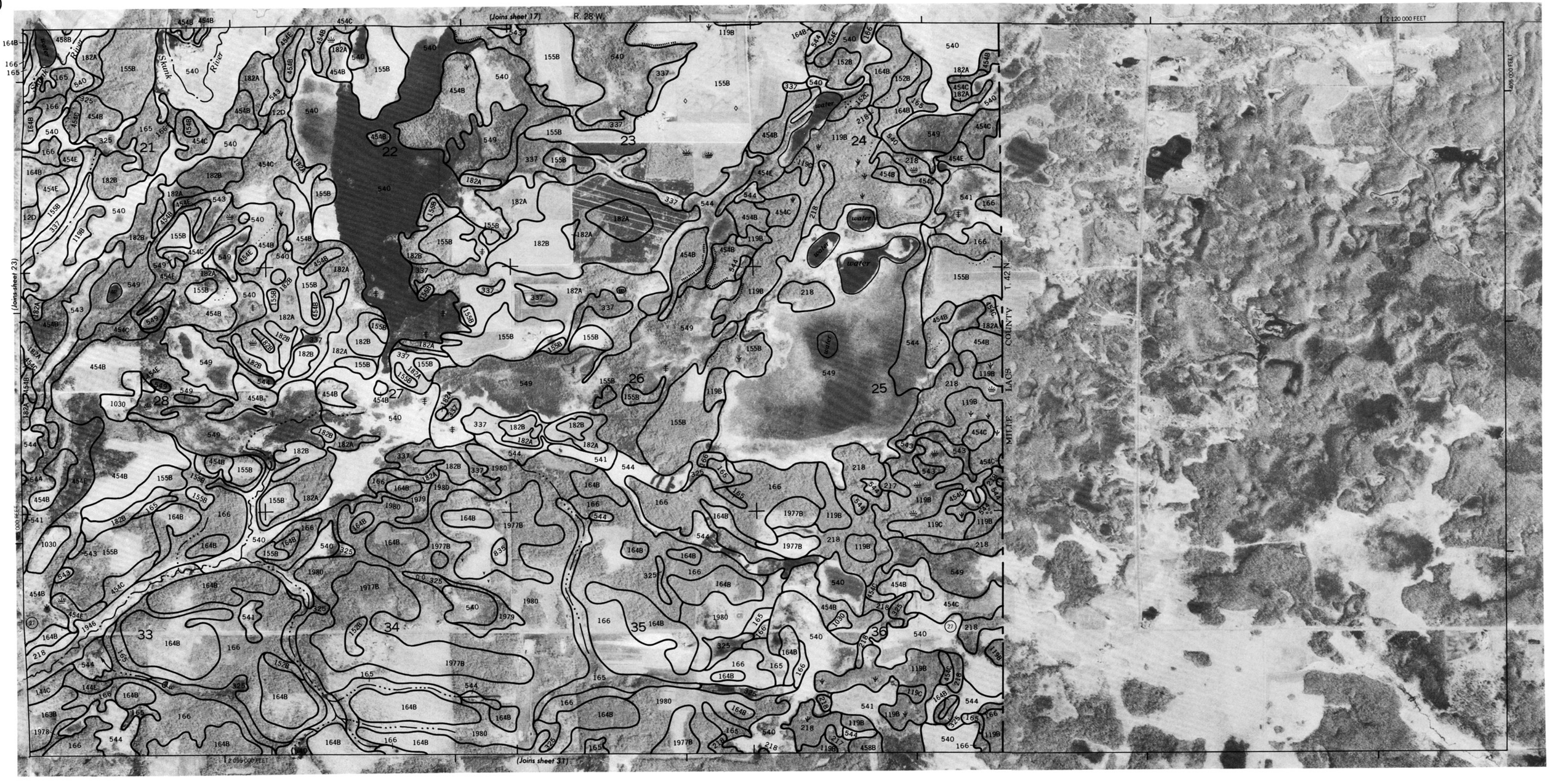
21

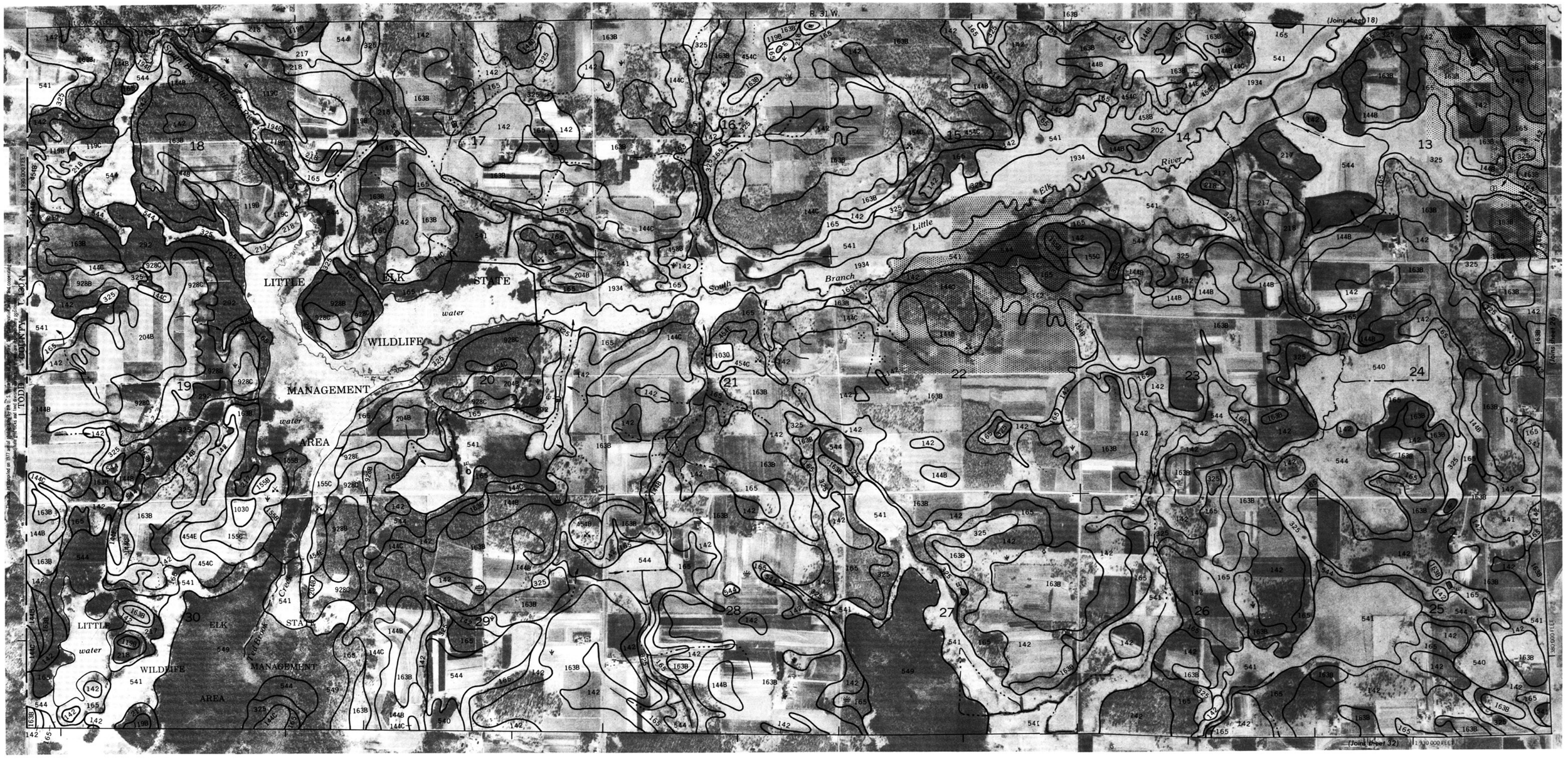
N

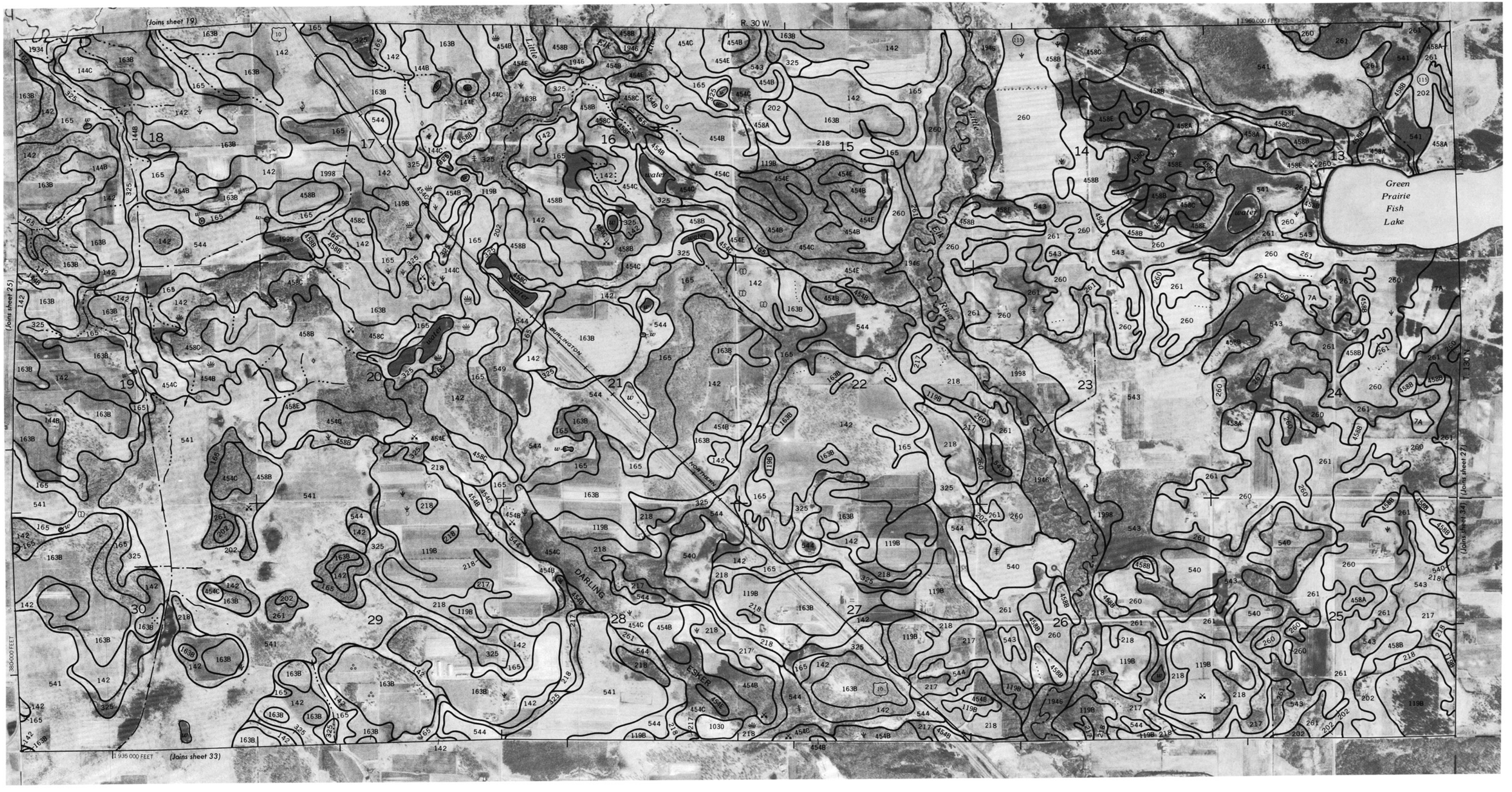

22
N
(Joins sheet 15)
R. 30 W.
R. 29 W.
Wolf Creek
Platte River
Platte River
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 29)
T. 42 N.
2 030 000 FEET
1 065 000 FEET

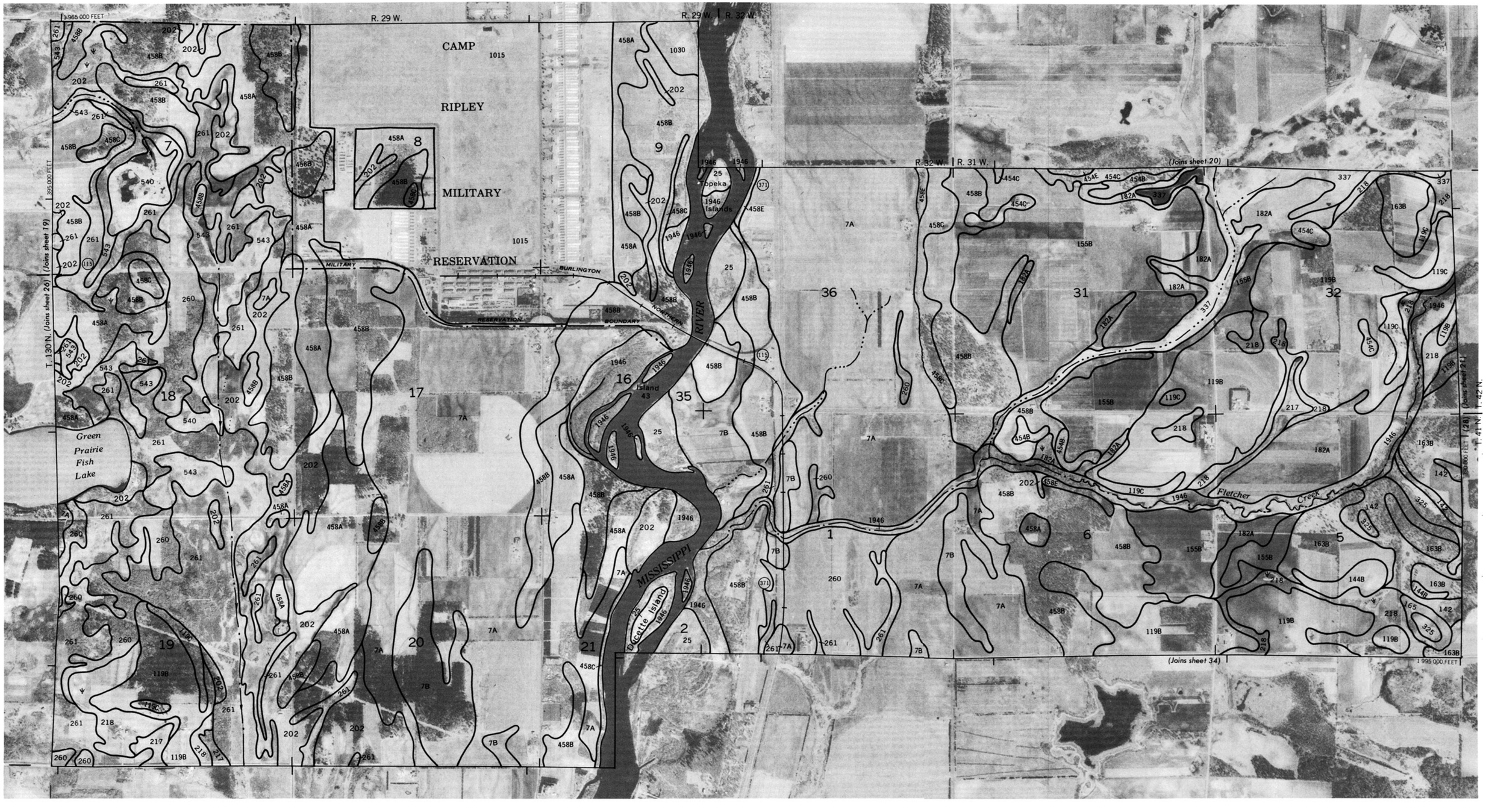

R. 29 W.
R. 28 W.
T. 42 N.
(Joins sheet 16)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 30)
2 060 000 FEET
2 090 000 FEET
Mud Lake
Christmas Lake
Skunk River
N

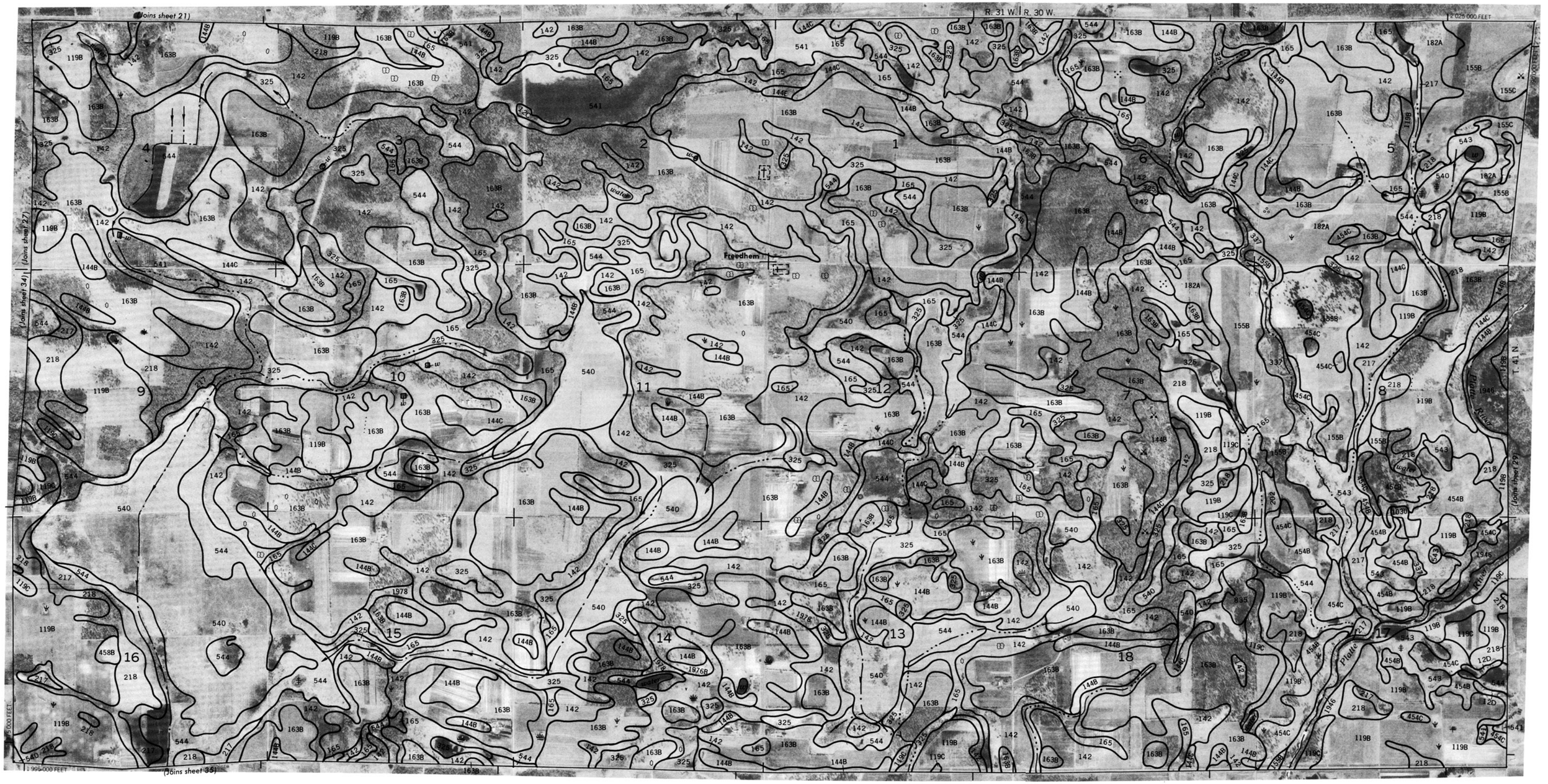
MORRISON COUNTY, MINNESOTA — SHEET NUMBER 24

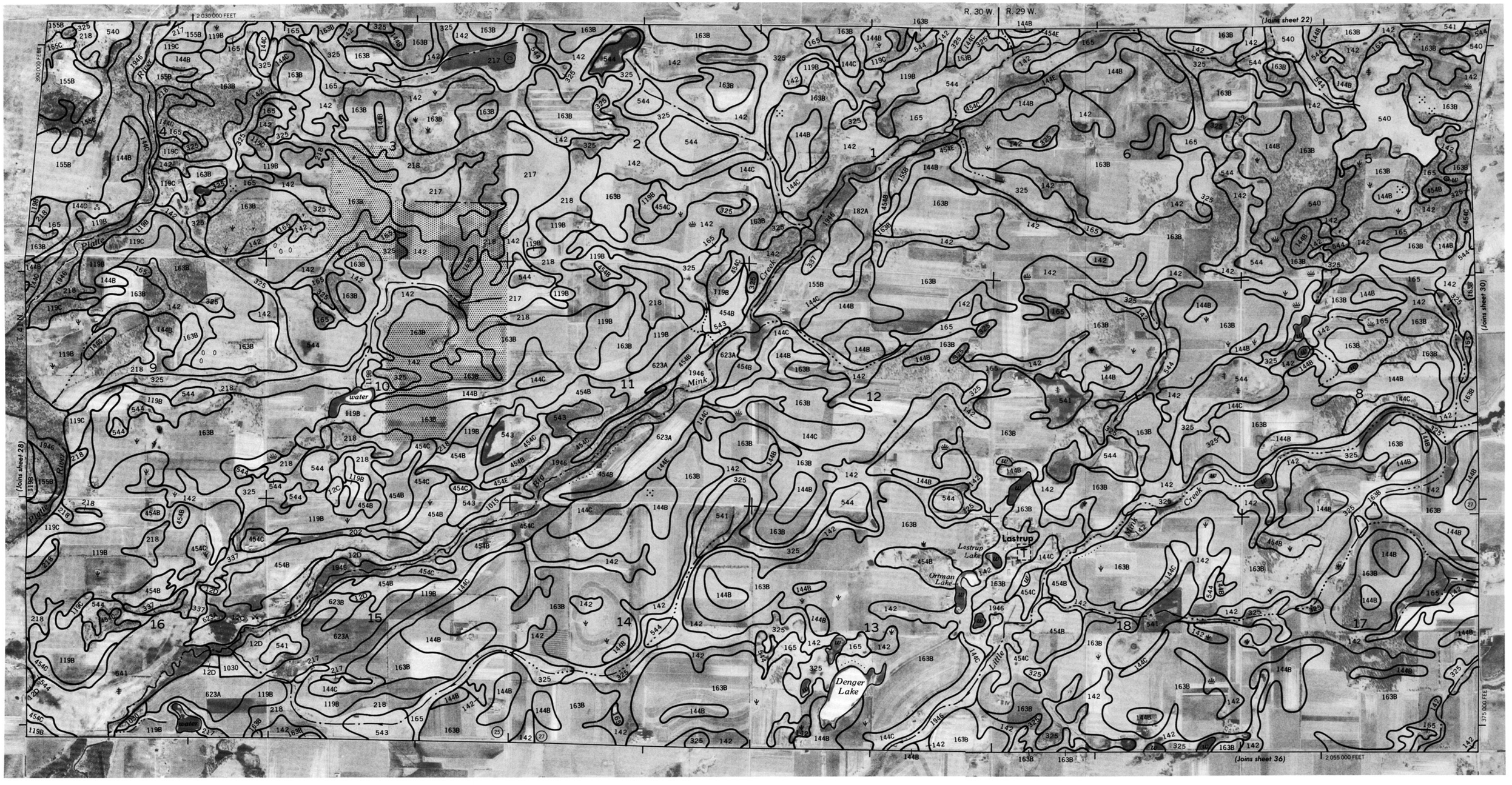



R. 31 W.
(Joins sheet 18)
(Joins sheet 24)
(Joins sheet 32)
LITTLE ELK STATE WILDLIFE MANAGEMENT AREA
water
South Branch Little Elk River
Creek
TODD COUNTY T. 130 N.
1 930 000 FEET
18
17
16
15
14
13
19
20
21
22
23
24
30
29
28
27
26
25

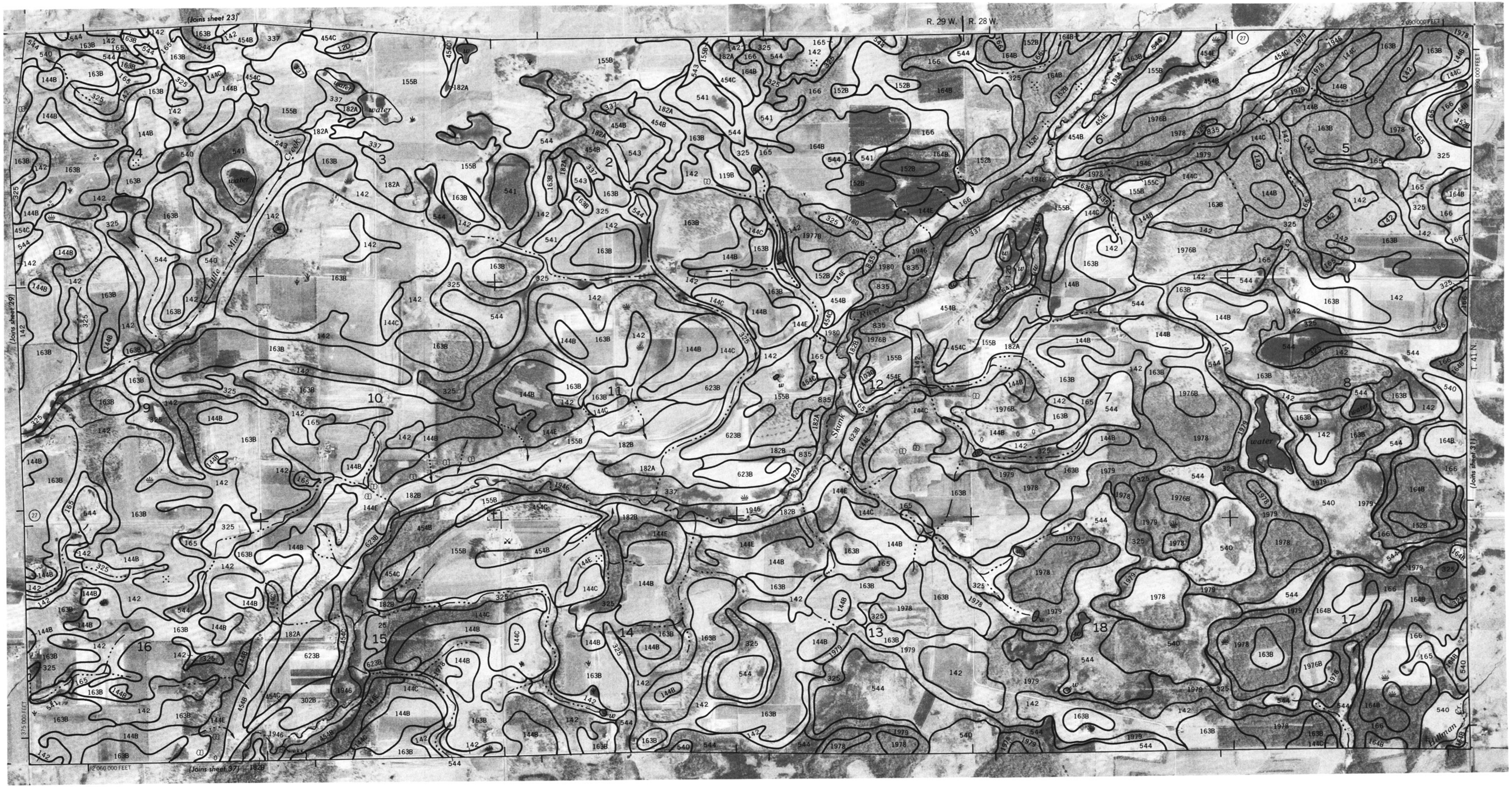

26
N
(Joins sheet 19)
R. 30 W.
1960 000 FEET
Little Elk River
Green Prairie Fish Lake
water
BURLINGTON NORTHERN
DARLING
ESKER
T. 130 N.
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 34)
385 000 FEET
1 935 000 FEET
(Joins sheet 33)

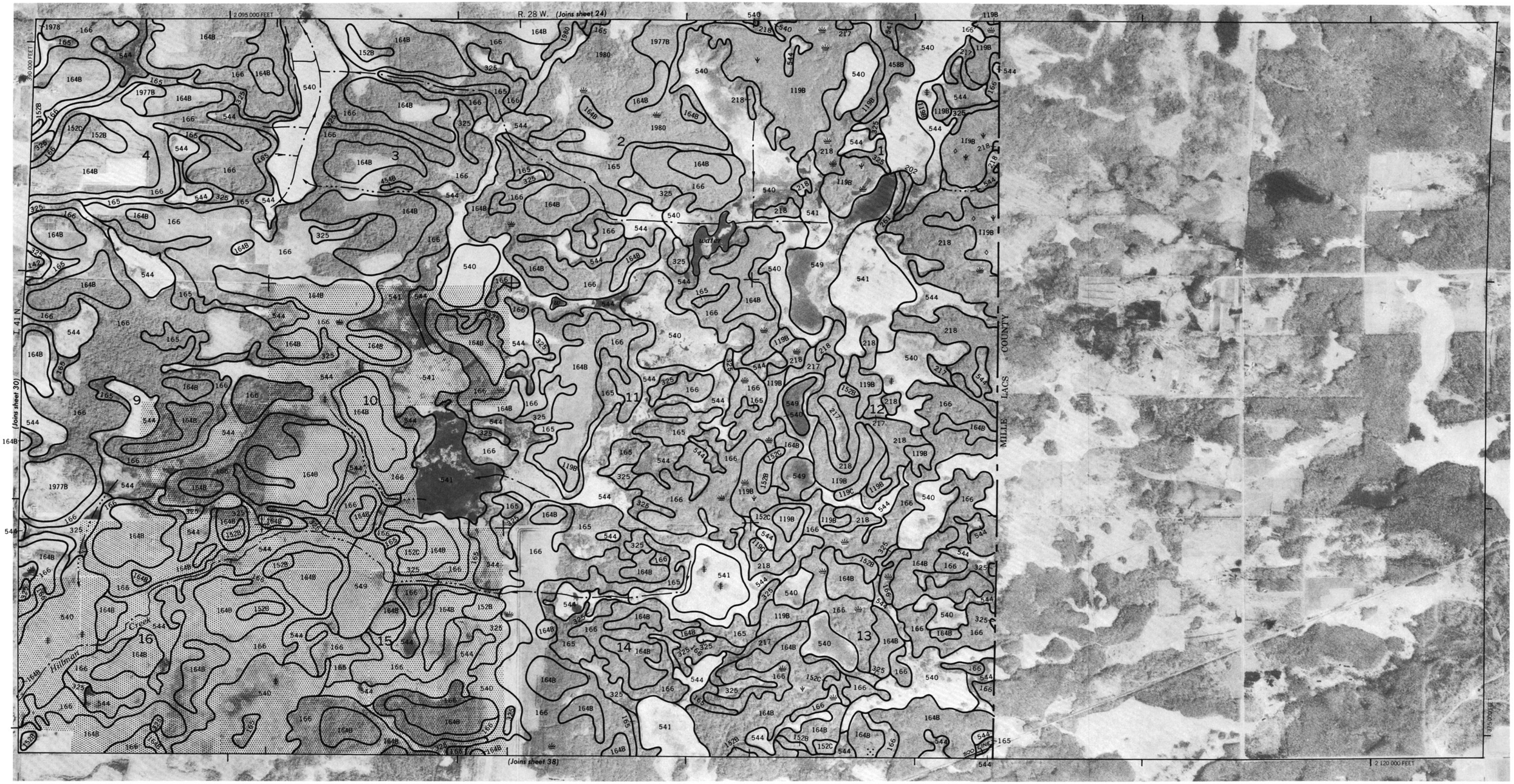

27
N
1 965 000 FEET
R. 29 W.
R. 32 W.
R. 31 W.
CAMP
RIPLEY
MILITARY
RESERVATION
MILITARY RESERVATION
BURLINGTON NORTHERN BOUNDARY
MISSISSIPPI RIVER
Green Prairie Fish Lake
Island 43
Dicette Island
Topeka Islands
Fletcher Creek
T. 130 N. (Joins sheet 26)
(Joins sheet 19)
(Joins sheet 20)
(Joins sheet 34)
(Joins sheet 27)
T. 42 N.
T. 41 N.
395 000 FEET
1 995 000 FEET

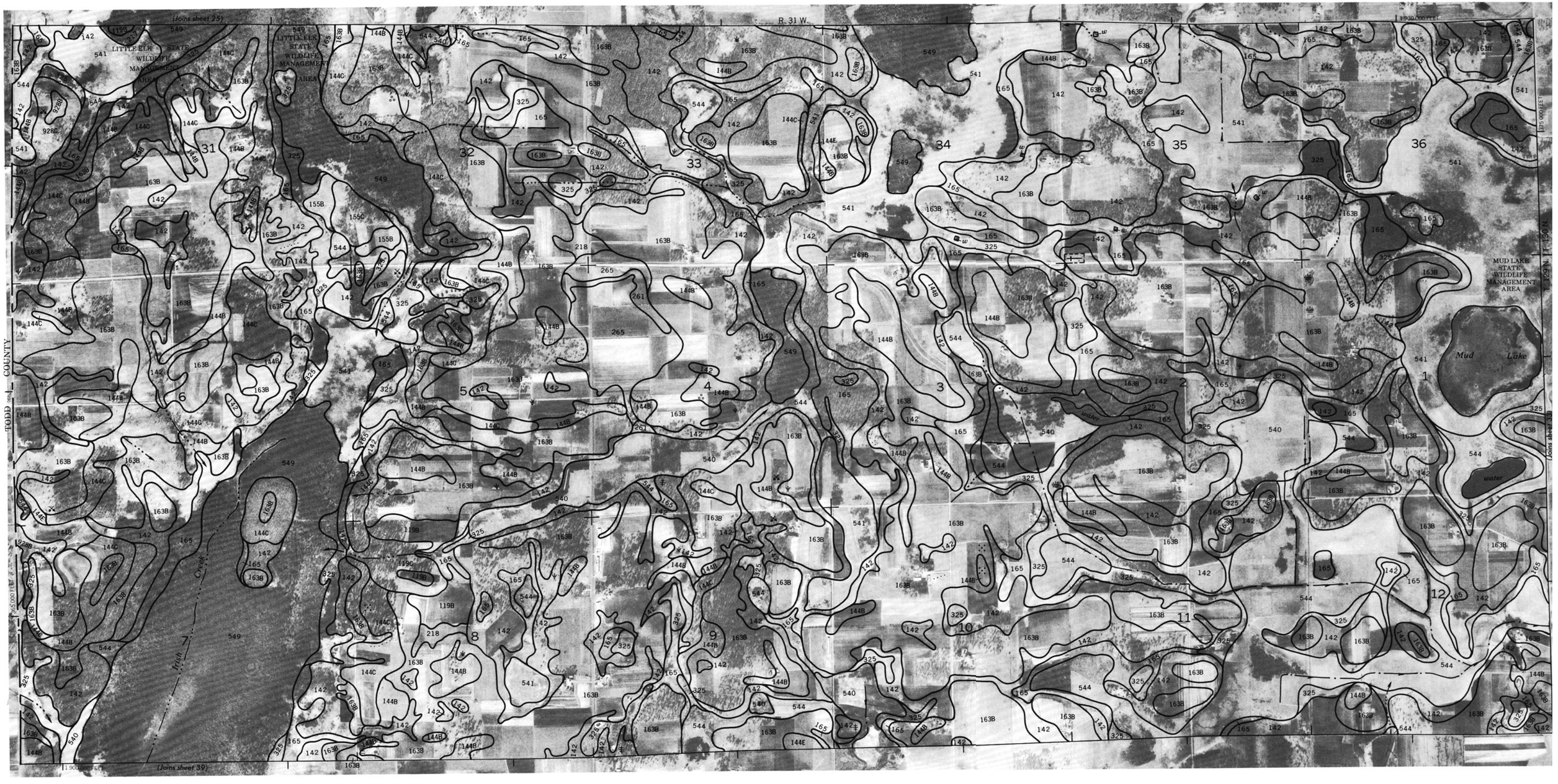

28
N
(Joins sheet 21)
R. 31 W.
R. 30 W.
2 025 000 FEET
(Joins sheet 27)
(Joins sheet 34)
T. 41 N.
Freedhem
Platte River
(Joins sheet 29)
1 995 000 FEET
(Joins sheet 35)

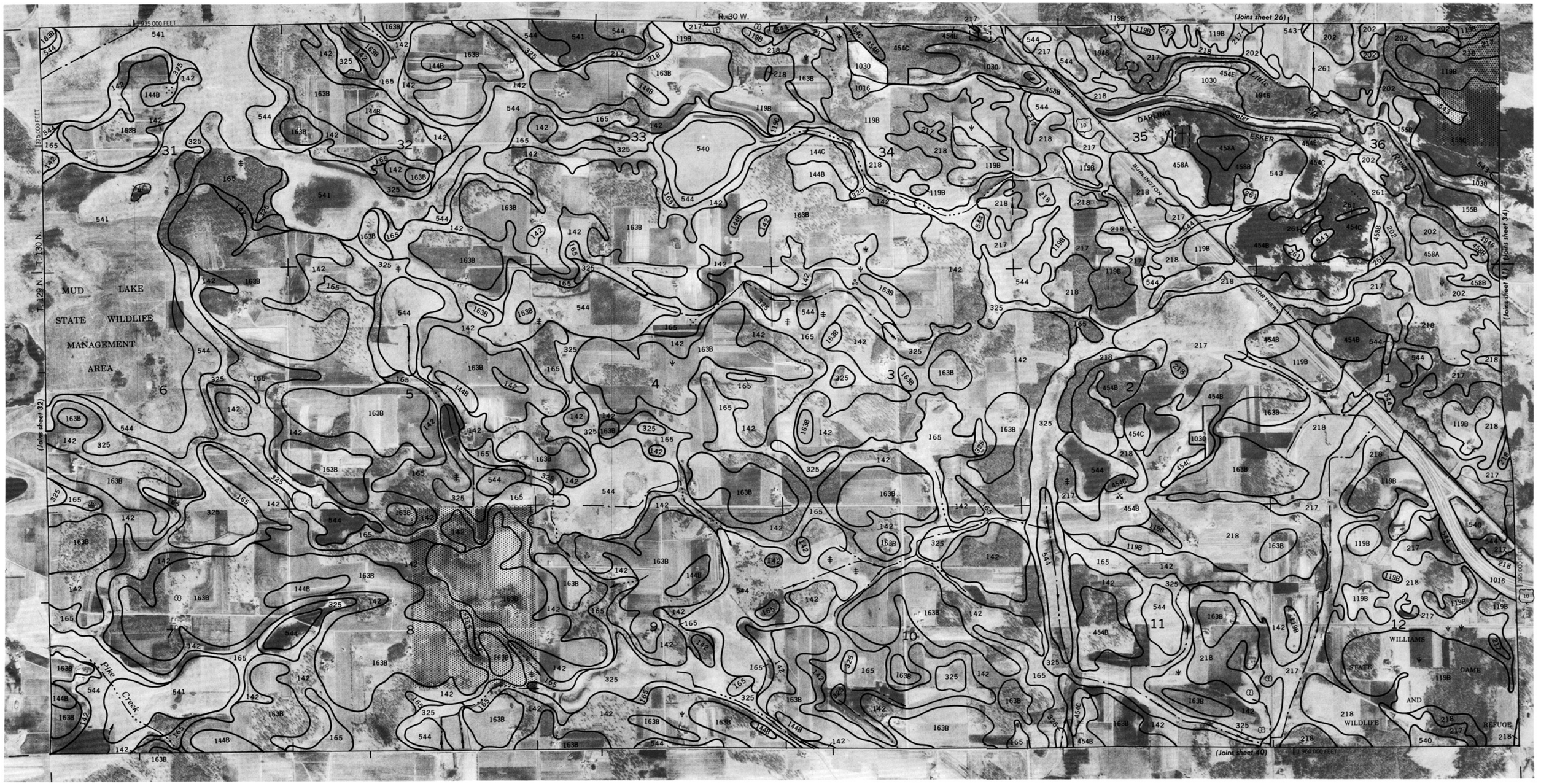

2 030 000 FEET
R. 30 W.
R. 29 W.
(Joins sheet 22)
390 000 FEET
T. 41 N.
(Joins sheet 28)
(Joins sheet 30)
(Joins sheet 36)
2 055 000 FEET
375 000 FEET
N
Platte River
Big Mink Creek
Little Mink Creek
Lastrup
Lastrup Lake
Ortman Lake
Denger Lake
water

N

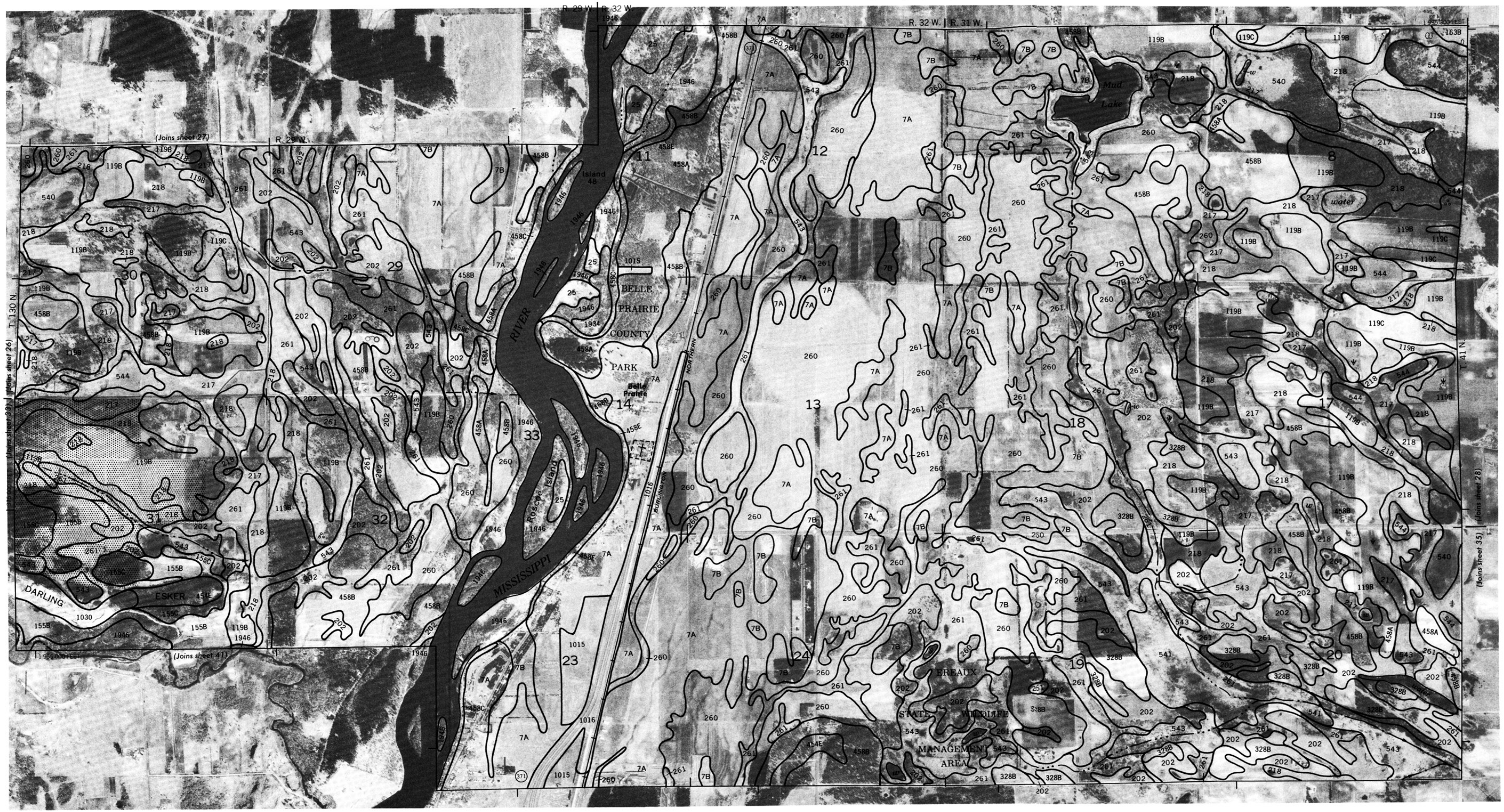

(Joins sheet 23)
R. 29 W.
R. 28 W.
2 090 000 FEET
390 000 FEET
T. 41 N.
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 37)
2 060 000 FEET
375 000 FEET
Little Mink Creek
Skunk River
Hillman Cr.
water

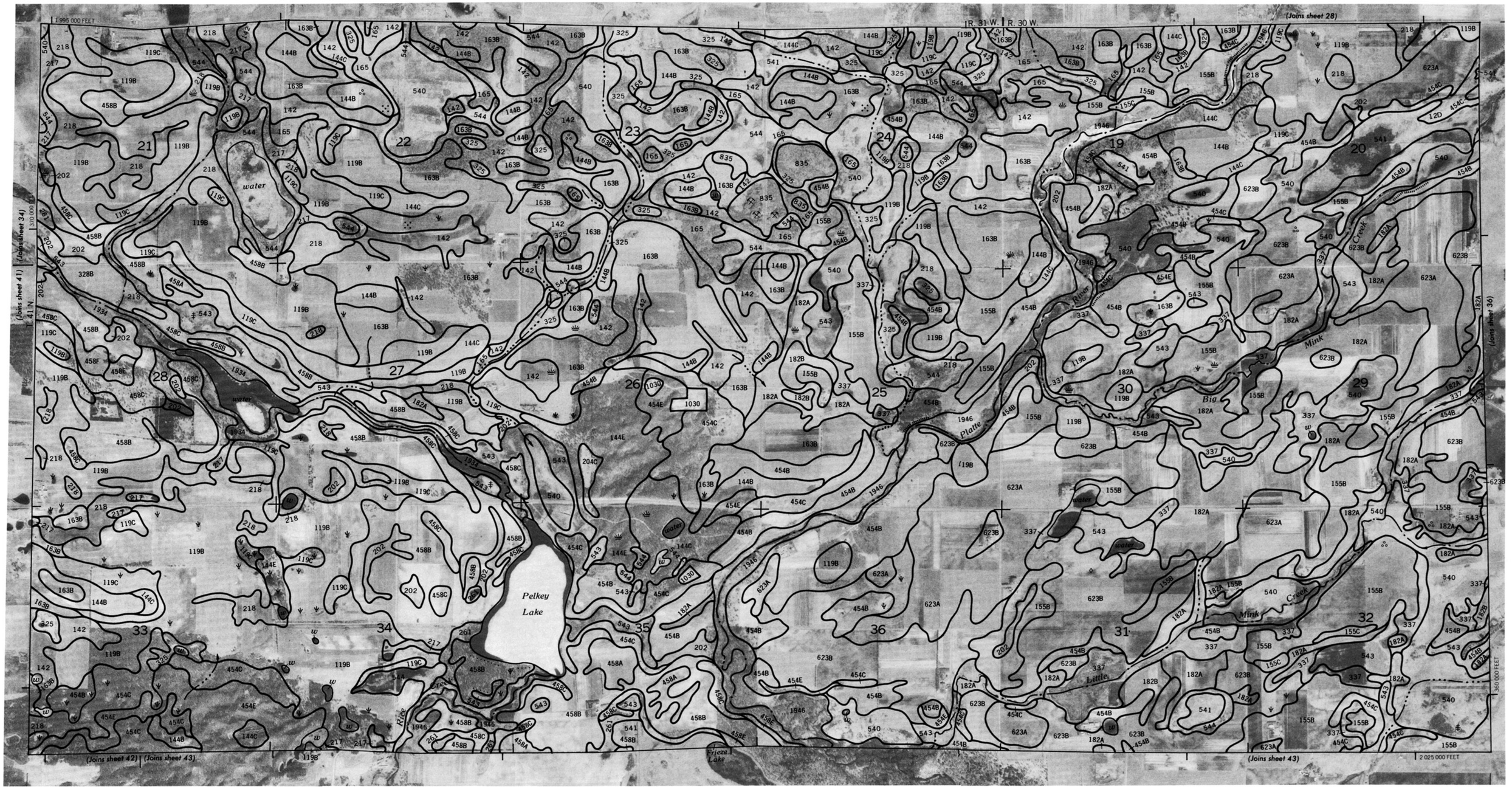

N
R. 28 W.
(Joins sheet 24)
2 095 000 FEET
390 000 FEET
T. 41 N.
(Joins sheet 30)
(Joins sheet 38)
2 120 000 FEET
MILLE LACS COUNTY
water
Hillman Creek
SCOTT LYNE


32
N
(Joins sheet 25)
R. 31 W.
LITTLE ELK STATE WILDLIFE MANAGEMENT AREA
MUD LAKE STATE WILDLIFE MANAGEMENT AREA
Mud Lake
water
Irish Creek
TODD COUNTY
T. 129 N.
(Joins sheet 39)
(Joins sheet 33)
31
32
33
34
35
36
1
2
3
4
5
6
7
8
9
10
11
12

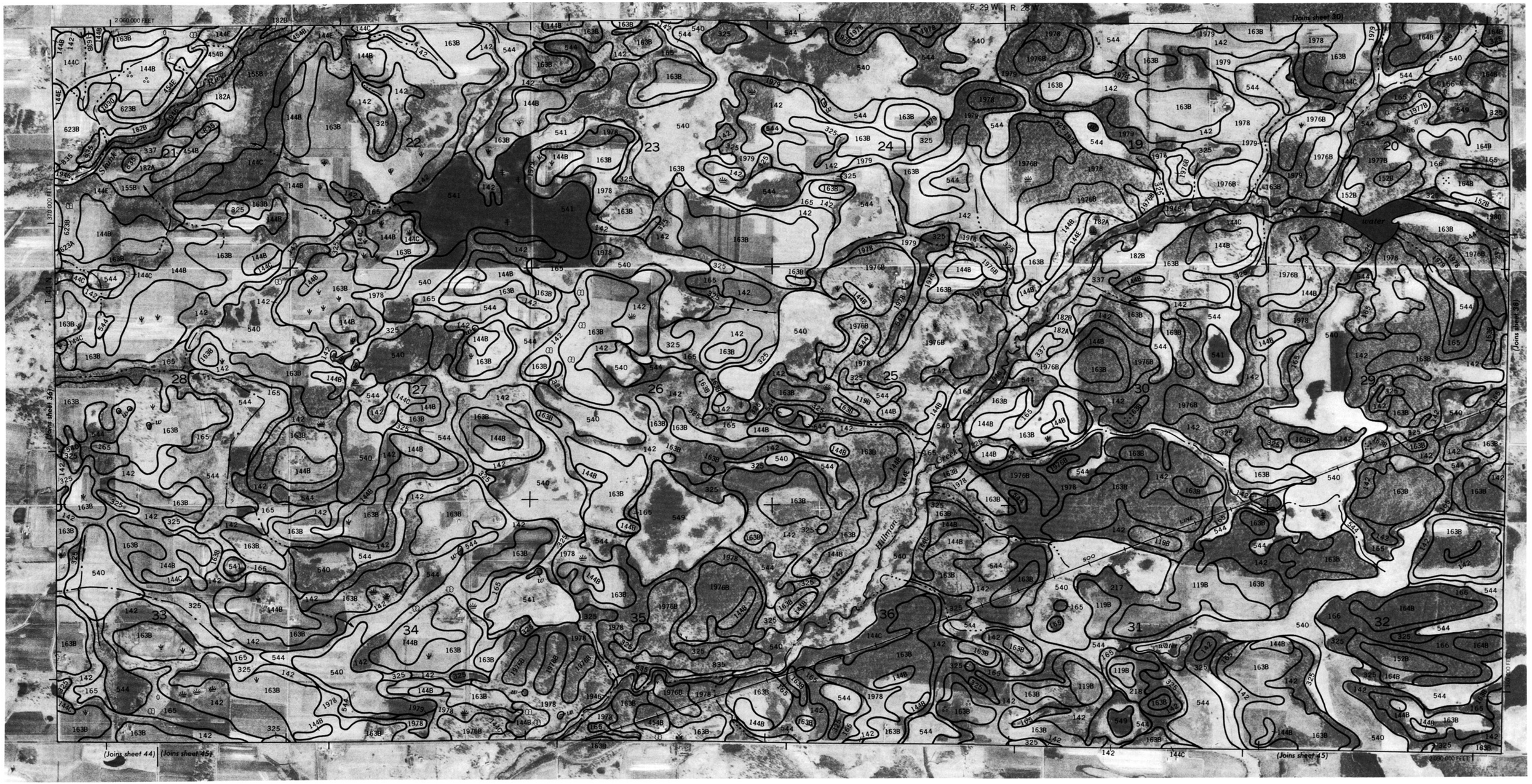

R. 30 W.
T. 130 N.
T. 129 N.
935 000 FEET
375 000 FEET
385 000 FEET
960 000 FEET
(Joins sheet 26)
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 40)
MUD LAKE STATE WILDLIFE MANAGEMENT AREA
DARLING
ESKER
Little Pike Creek
BURLINGTON
NORTHERN
WILLIAMS STATE GAME AND WILDLIFE REFUGE
Pike Creek

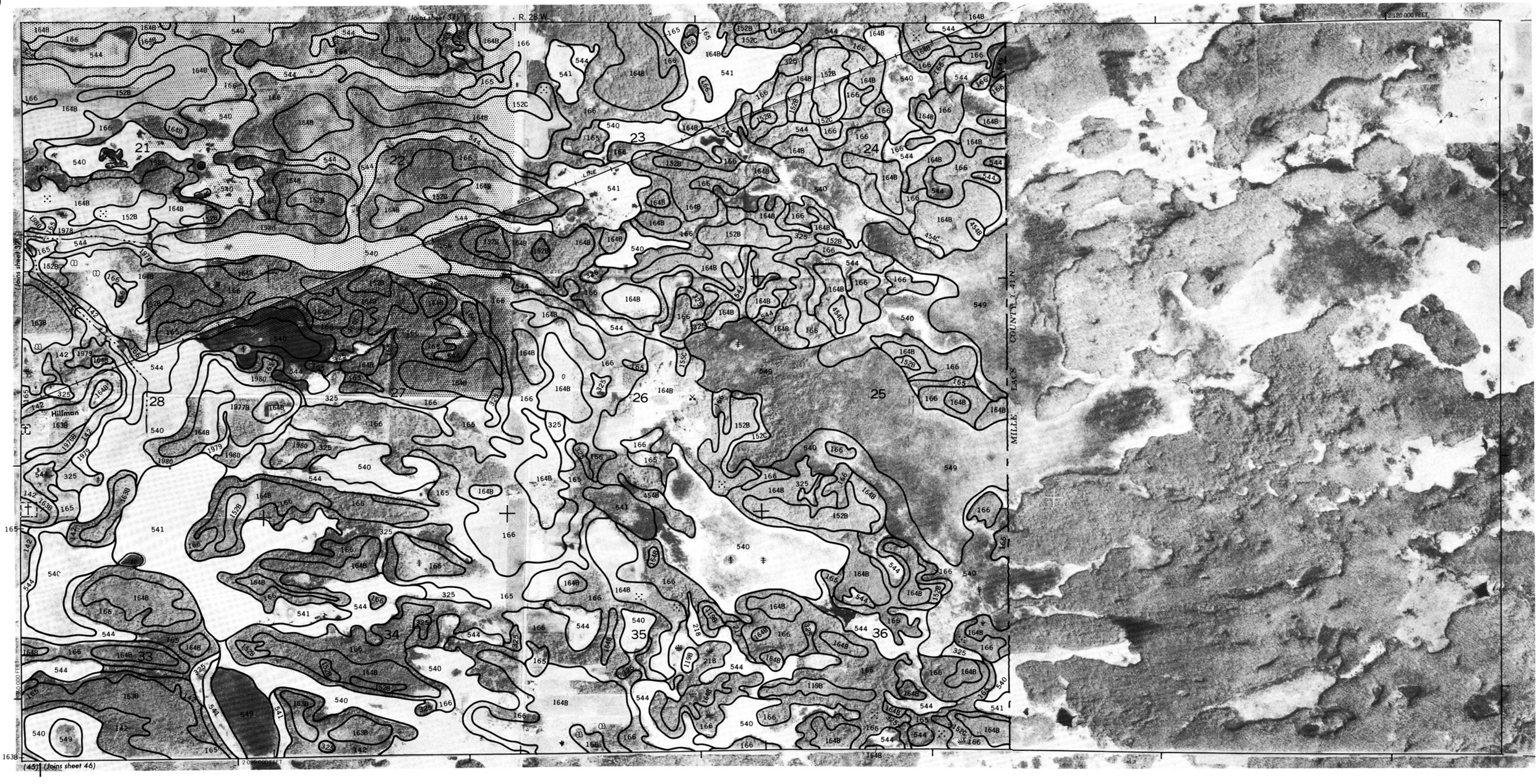
N


R. 29 W.
R. 32 W.
R. 31 W.
(Joins sheet 27)
(Joins sheet 26)
(Joins sheet 33)
(Joins sheet 41)
(Joins sheet 28)
(Joins sheet 35)
T. 130 N.
T. 41 N.
Mud Lake
water
Island 48
BELLE PRAIRIE COUNTY PARK
Belle Prairie
MISSISSIPPI RIVER
Roscoe Island
BURLINGTON NORTHERN
DARLING ESKER
EREAUX STATE WILDLIFE MANAGEMENT AREA
371


N
R. 31 W.
R. 30 W.
T. 41 N.
1 995 000 FEET
2 025 000 FEET
360 000 FEET
(Joins sheet 28)
(Joins sheet 34)
(Joins sheet 41)
(Joins sheet 36)
(Joins sheet 42)
(Joins sheet 43)
(Joins sheet 43)
Pelkey Lake
Frieze Lake
Rice Creek
Little Mink Creek
Mink Creek
Big Platte River
water

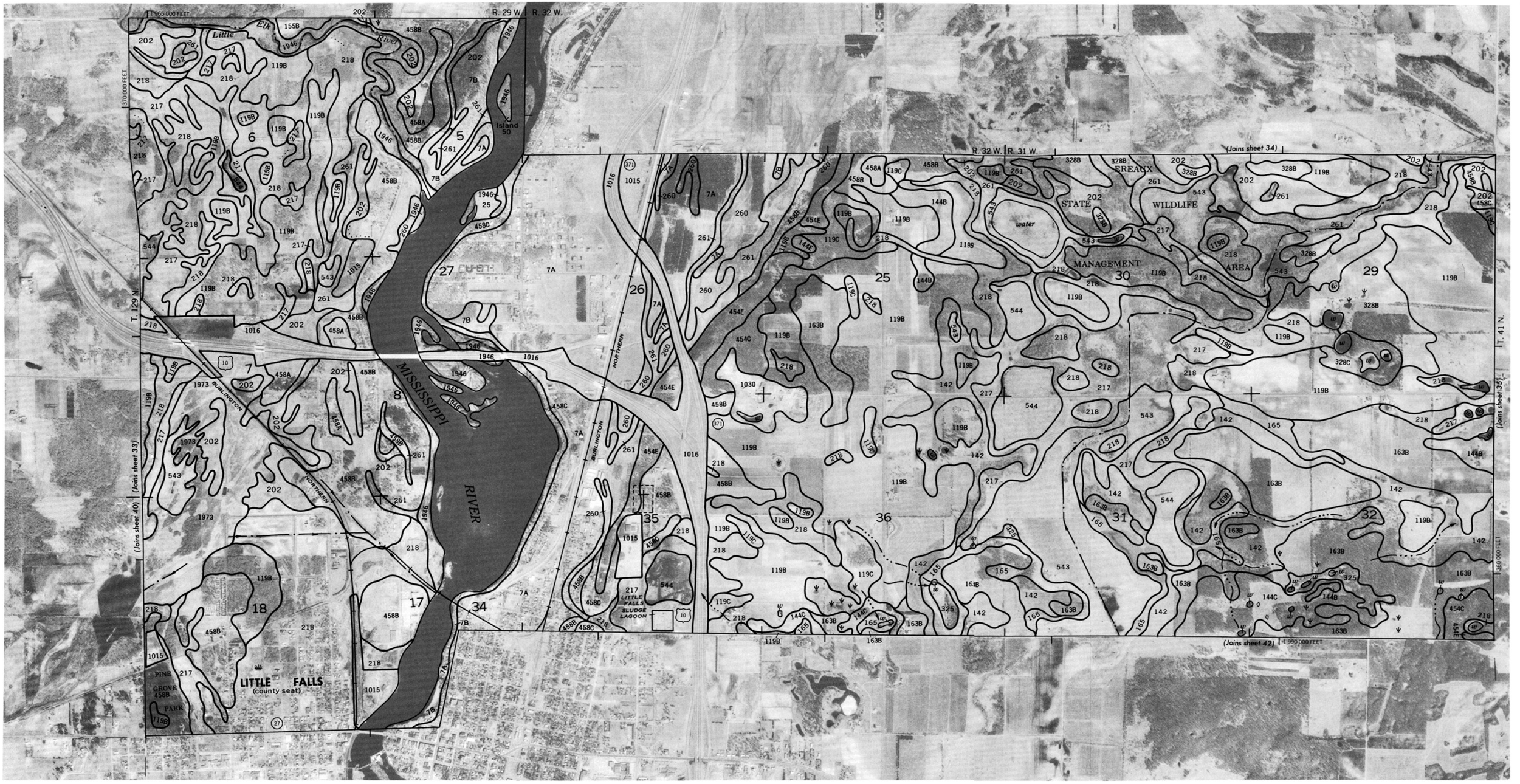

36
N
(Joins sheet 29)
R. 30 W.
R. 29 W.
2 055 000 FEET
370 000 FEET
T. 41 N.
(Joins sheet 35)
(Joins sheet 37)
380 000 FEET
2 030 000 FEET
(Joins sheet 43)
(Joins sheet 44)
Little Mink Creek
Mink Creek
Skunk River
PIERZ
21
22
23
24
19
20
28
27
26
25
30
29
33
34
35
36
31
32

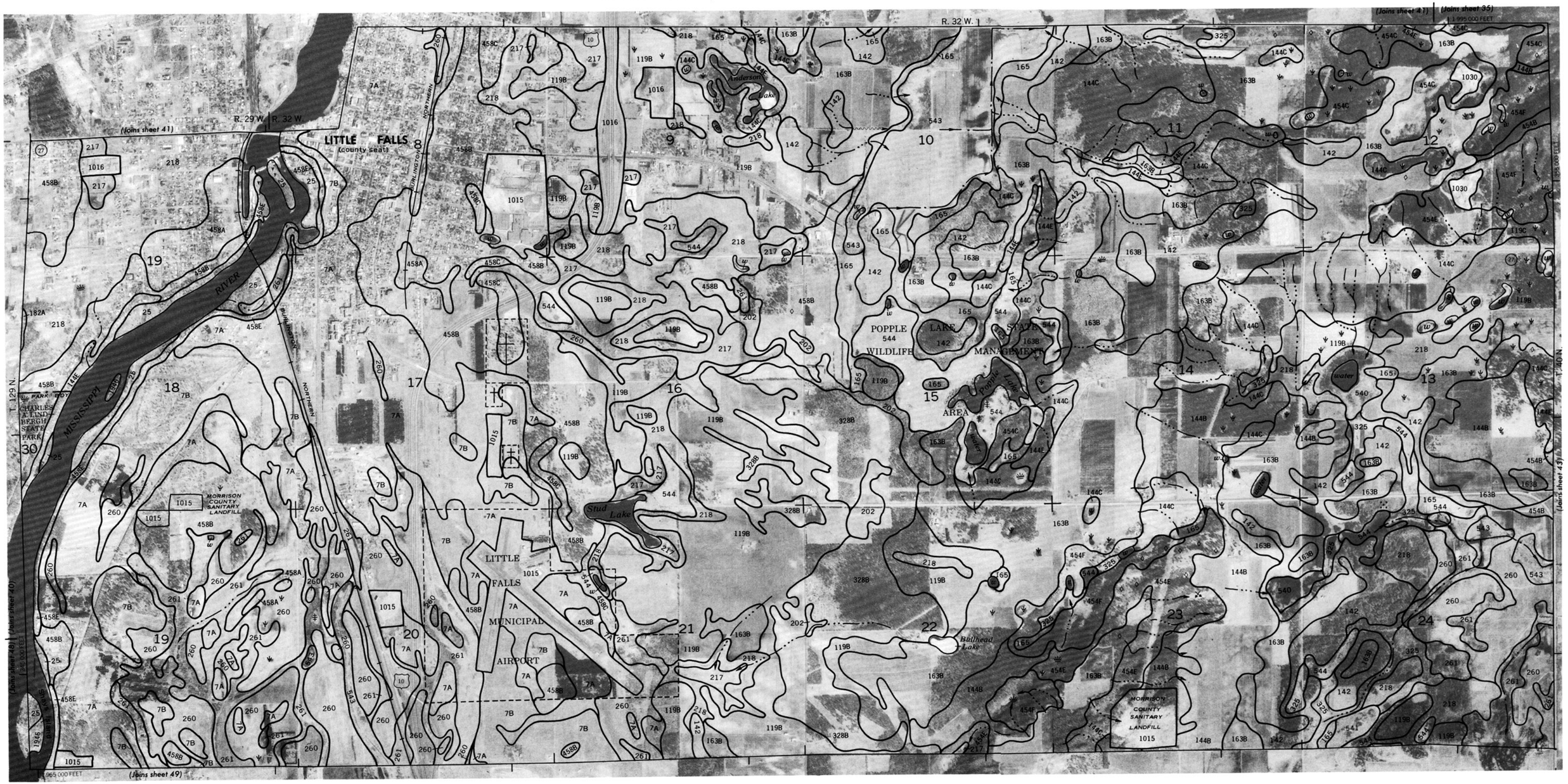

R. 29 W.
R. 28 W.
(Joins sheet 30)
(Joins sheet 36)
(Joins sheet 37)
(Joins sheet 44)
(Joins sheet 45)
(Joins sheet 45)
2 060 000 FEET
2 070 000 FEET
2 080 000 FEET
water
Elliman
soo
line

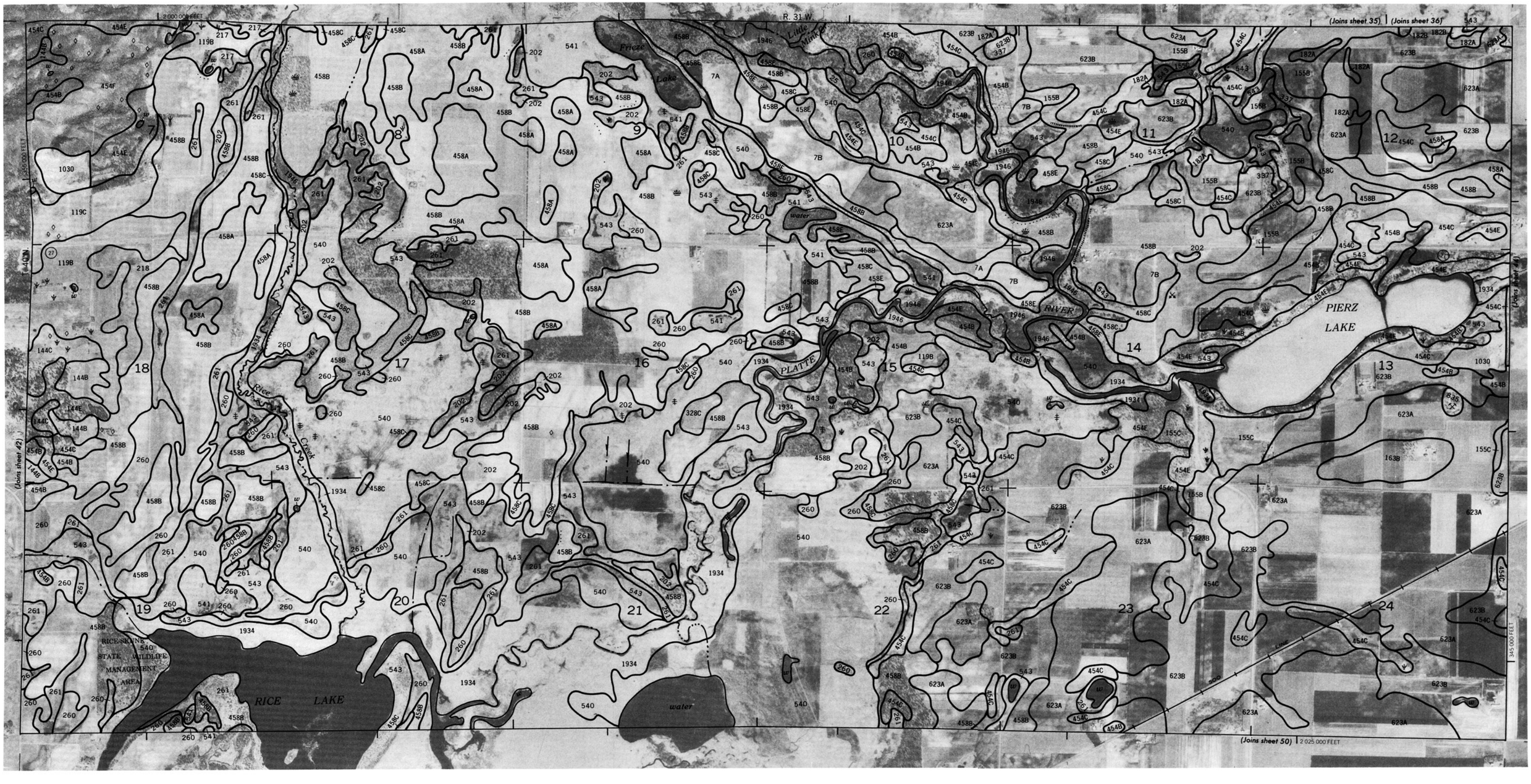

38
N
(Joins sheet 37)
R. 28 W.
2120 000 FEET
MILLE LACS COUNTY
Hillman
(45) (Joins sheet 46)
2090 000 FEET

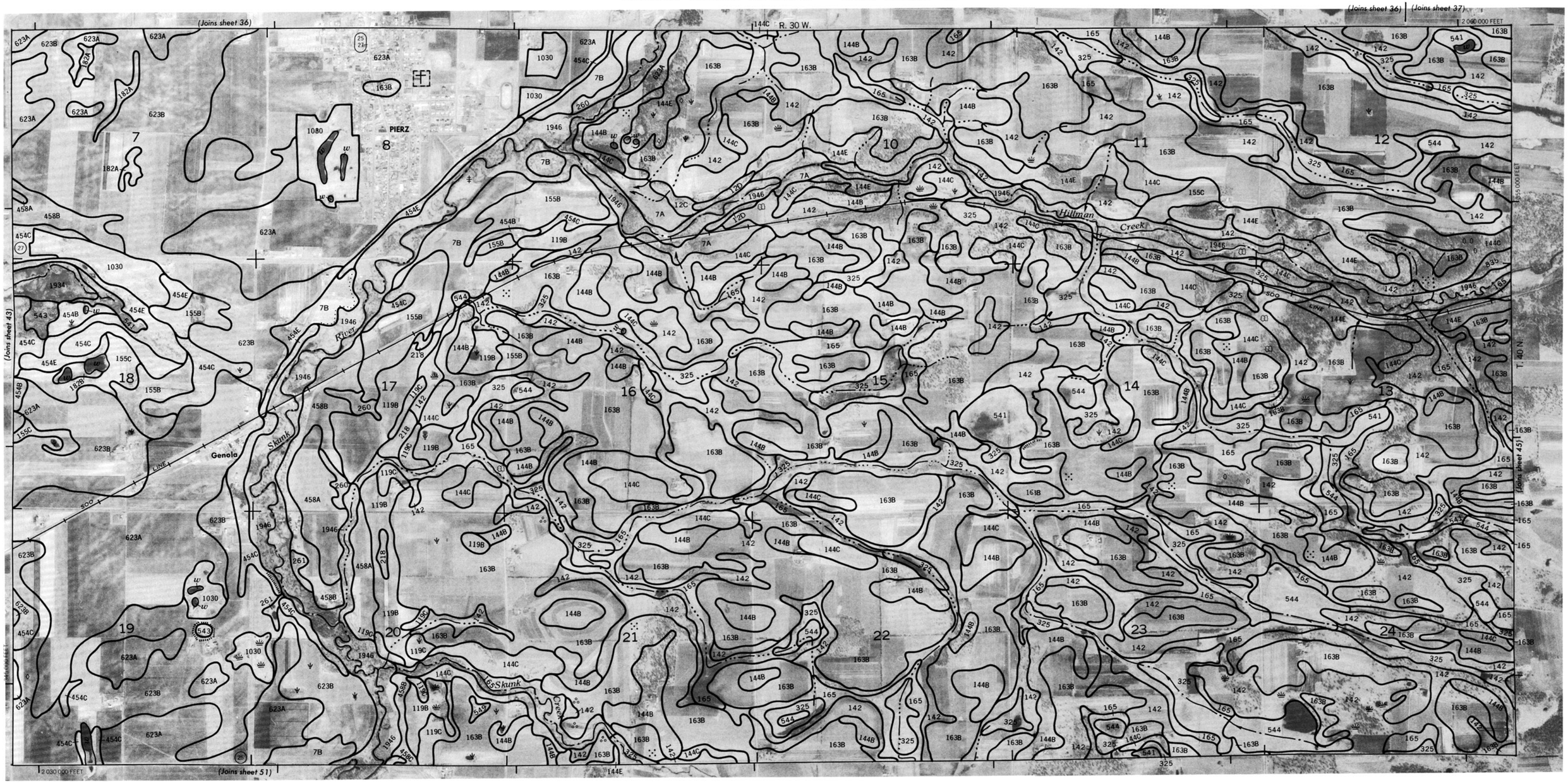

R. 31 W.
T. 129 N.
TODD COUNTY
1 900 000 FEET
1 930 000 FEET
350 000 FEET
(Joins sheet 32)
(Joins sheet 40)
(Joins sheet 47)
Beauty Lake
Irish Creek
Johnson Lake
Prospect Lake
Flensburg
FLENSBURG LAGOON
water
18
17
16
15
14
13
19
20
21
22
23
24
30
29
28
27
26
25


40
N
(Joins sheet 33)
R. 30 W.
(Joins sheet 39)
(Joins sheet 41)
(Joins sheet 48)
West Twin Lake
East Twin Lake
Pike Creek
WILLIAMS
STATE GAME
AND WILDLIFE
REFUGE
CHARLES A. LINDBERGH STATE PARK
MISSISSIPPI RIVER
1 360 000 FEET
1 935 000 FEET

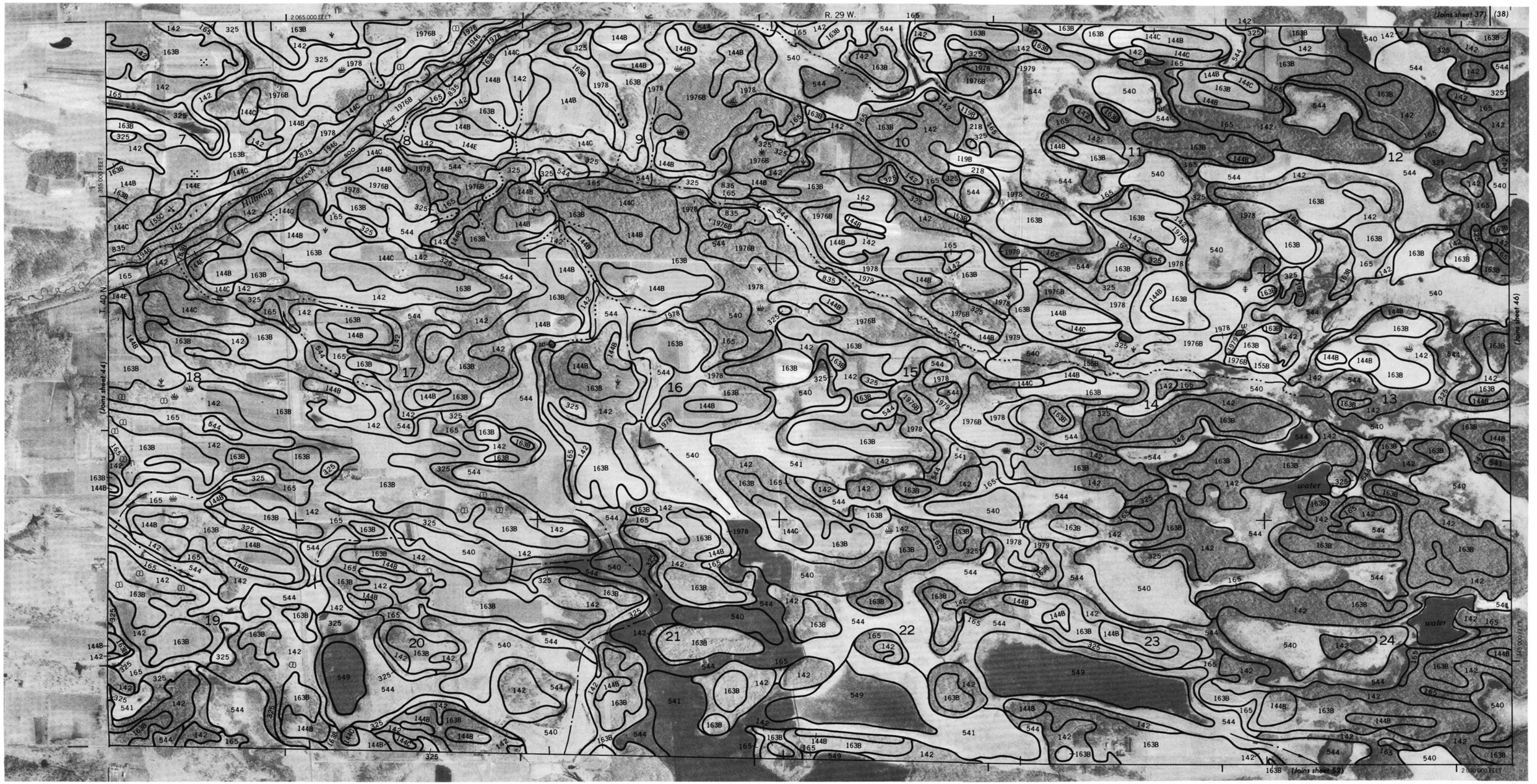

41
N
R. 29 W.
R. 32 W.
R. 31 W.
T. 129 N.
T. 41 N.
1,965,000 FEET
370,000 FEET
1,990,000 FEET
360,000 FEET
Little Elk River
MISSISSIPPI RIVER
Island 50
NORTHERN
BURLINGTON
LITTLE FALLS
(county seat)
PINE GROVE PARK
SLUDGE LAGOON
STATE WILDLIFE MANAGEMENT AREA
water
(Joins sheet 33)
(Joins sheet 34)
(Joins sheet 35)
(Joins sheet 40)
(Joins sheet 42)

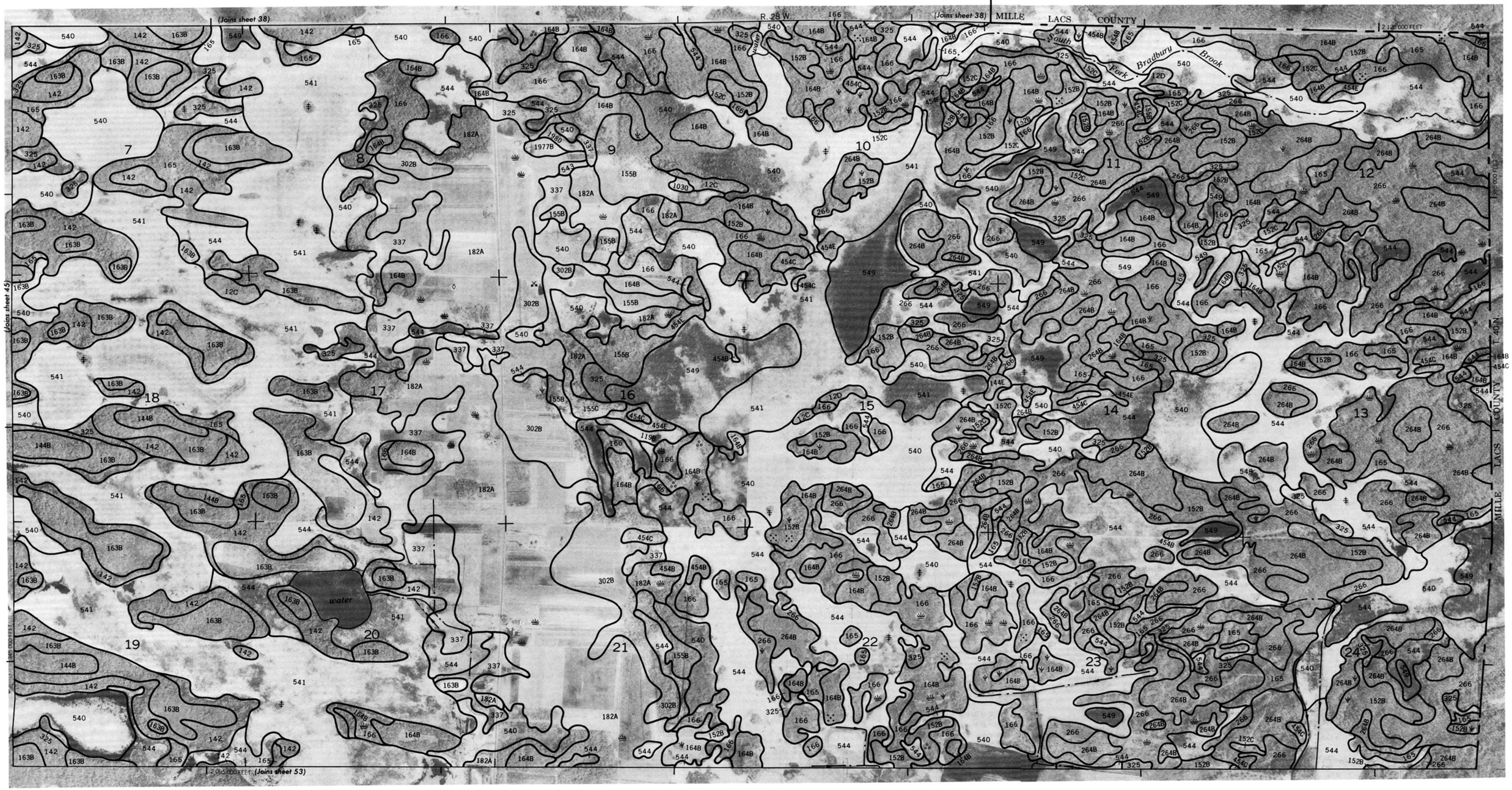

42
N
R. 29 W.
R. 32 W.
(Joins sheet 41)
LITTLE FALLS
(county seat)
NORTHERN
BURLINGTON
MISSISSIPPI
RIVER
CHARLES A. LINDBERGH STATE PARK
MORRISON COUNTY SANITARY LANDFILL
LITTLE FALLS MUNICIPAL AIRPORT
Stud Lake
Anderson Lake
POPPLE LAKE WILDLIFE MANAGEMENT AREA
Popple Lake
Bullhead Lake
MORRISON COUNTY SANITARY LANDFILL
(Joins sheet 40)
(Joins sheet 43)
(Joins sheet 49)
T. 129 N.
T. 130 N.
1,965,000 FEET
1,995,000 FEET


N
R. 31 W.
(Joins sheet 35)
(Joins sheet 36)
(Joins sheet 42)
(Joins sheet 41)
(Joins sheet 50)
2 000 000 FEET
2 025 000 FEET
350 000 FEET
345 000 FEET
T 40 N
Little Mink
Frieze Lake
Rice Creek
PLATTE RIVER
PIERZ LAKE
RICE LAKE
RICE LAKE STATE WILDLIFE MANAGEMENT AREA
water
Lane
Road

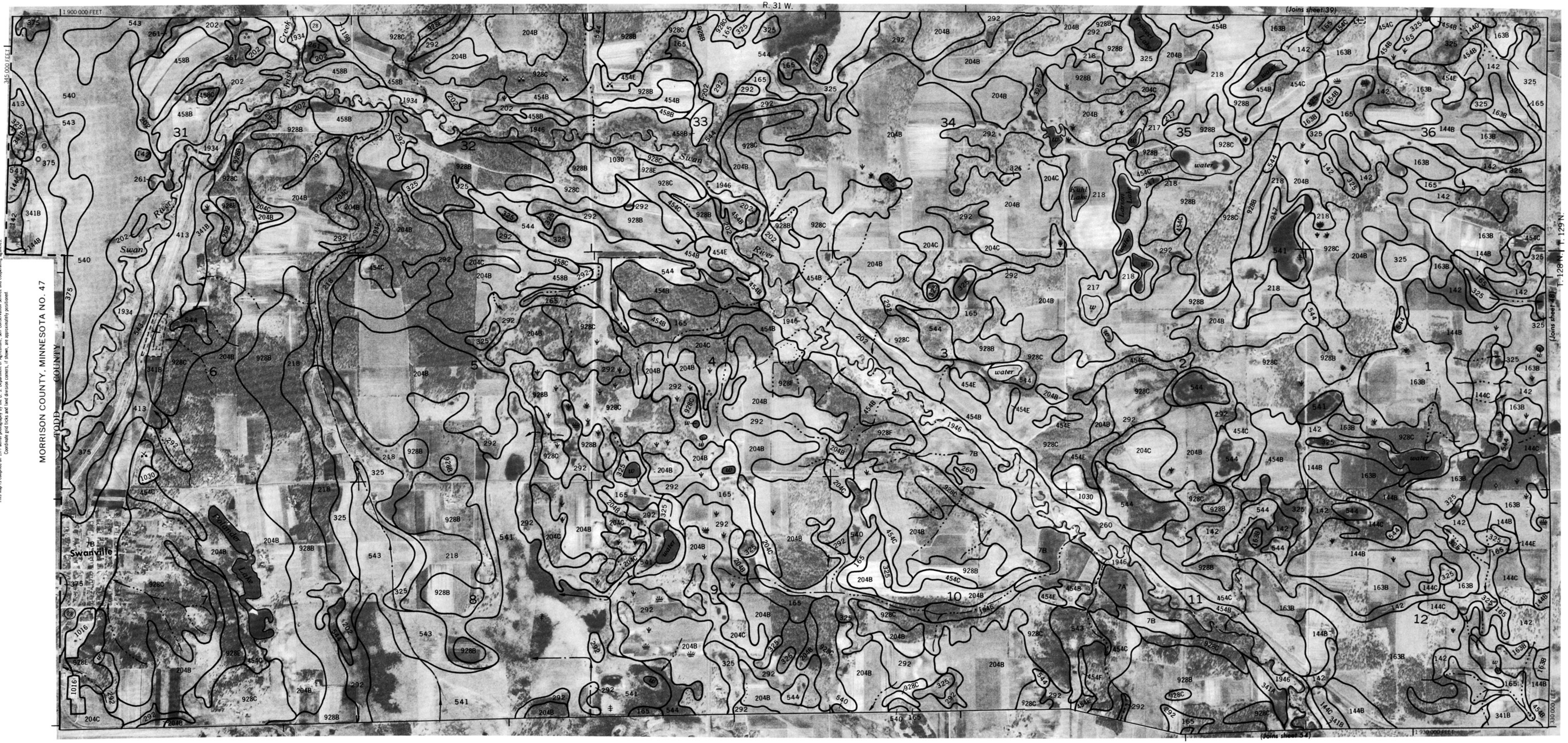

44
N
(Joins sheet 36)
(Joins sheet 36)
(Joins sheet 37)
R. 30 W.
PIERZ
Genola
Skunk River
Hillman Creek
Skunk Creek
(Joins sheet 43)
(Joins sheet 45)
(Joins sheet 51)
T. 40 N.
2 060 000 FEET
2 055 000 FEET
2 050 000 FEET
2 030 000 FEET
LINE
500

MORRISON COUNTY, MINNESOTA — SHEET NUMBER 45



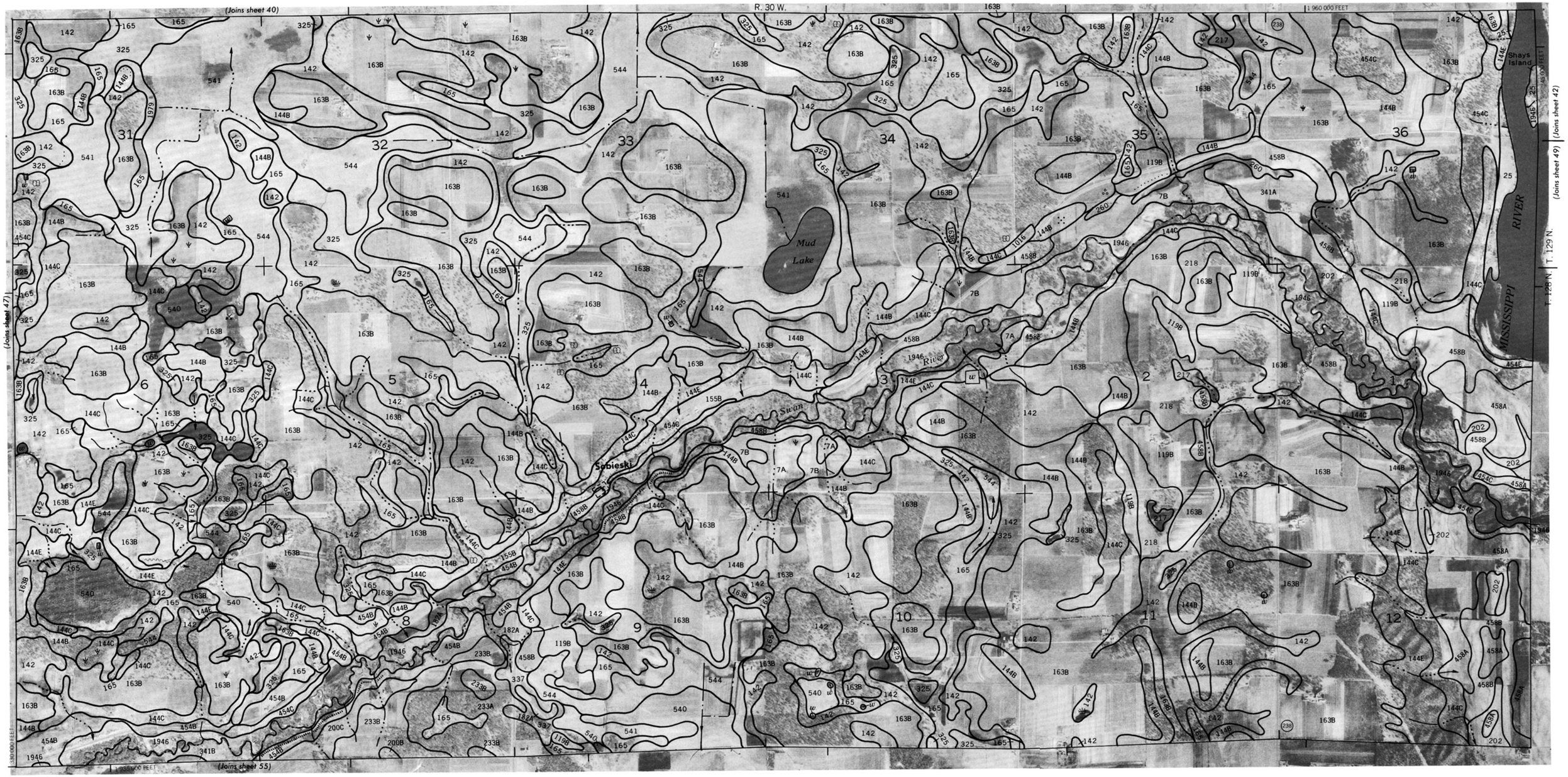

46
N
(Joins sheet 38)
R. 28 W.
(Joins sheet 38)
MILLE LACS COUNTY
2 120 000 FEET
South Bradbury Fork Brook
water
water
(Joins sheet 45)
2 095 000 FEET
(Joins sheet 53)
T. 40 N.
MILLE LACS COUNTY

47



MORRISON COUNTY, MINNESOTA NO. 47

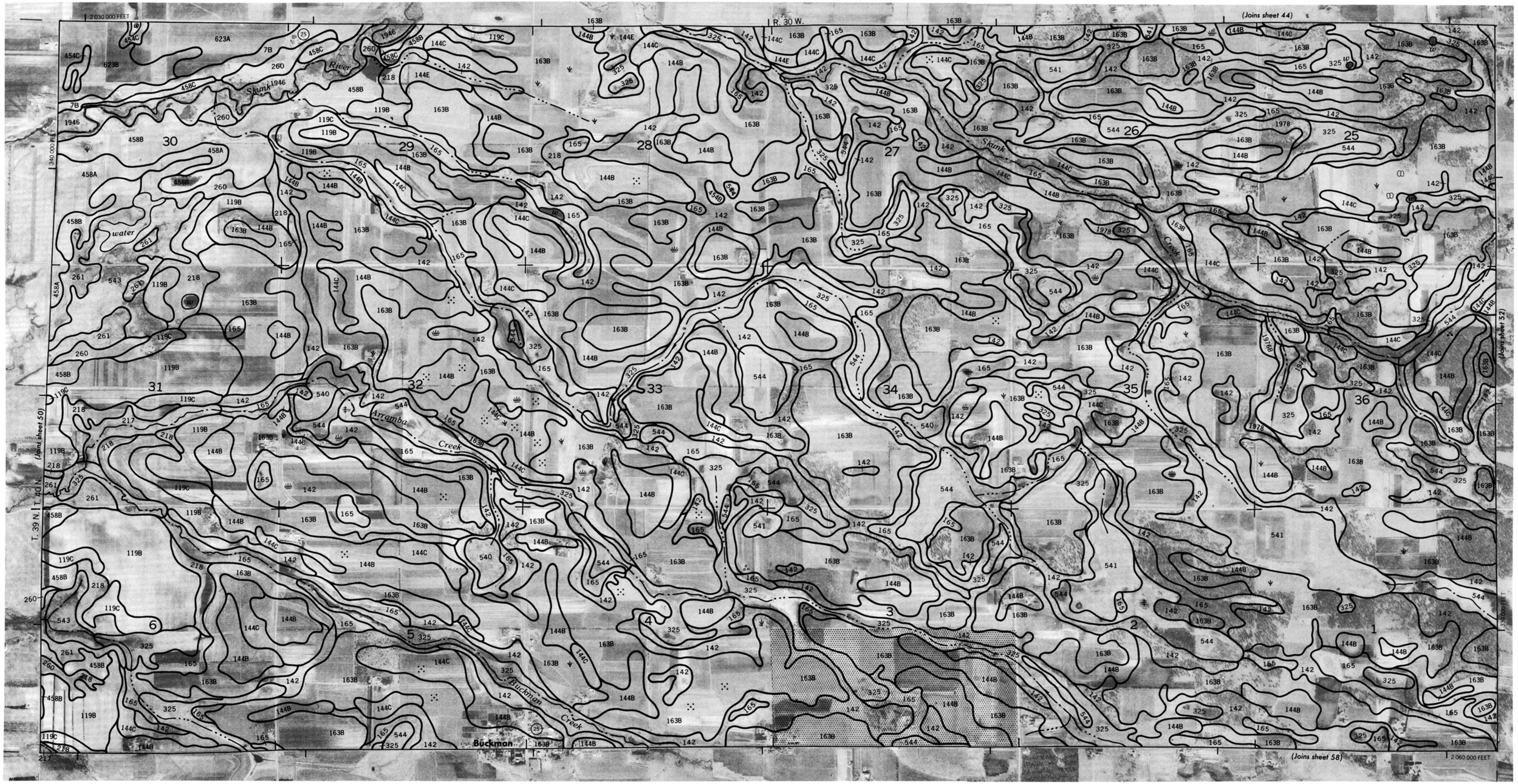
This map is compiled on 1977 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

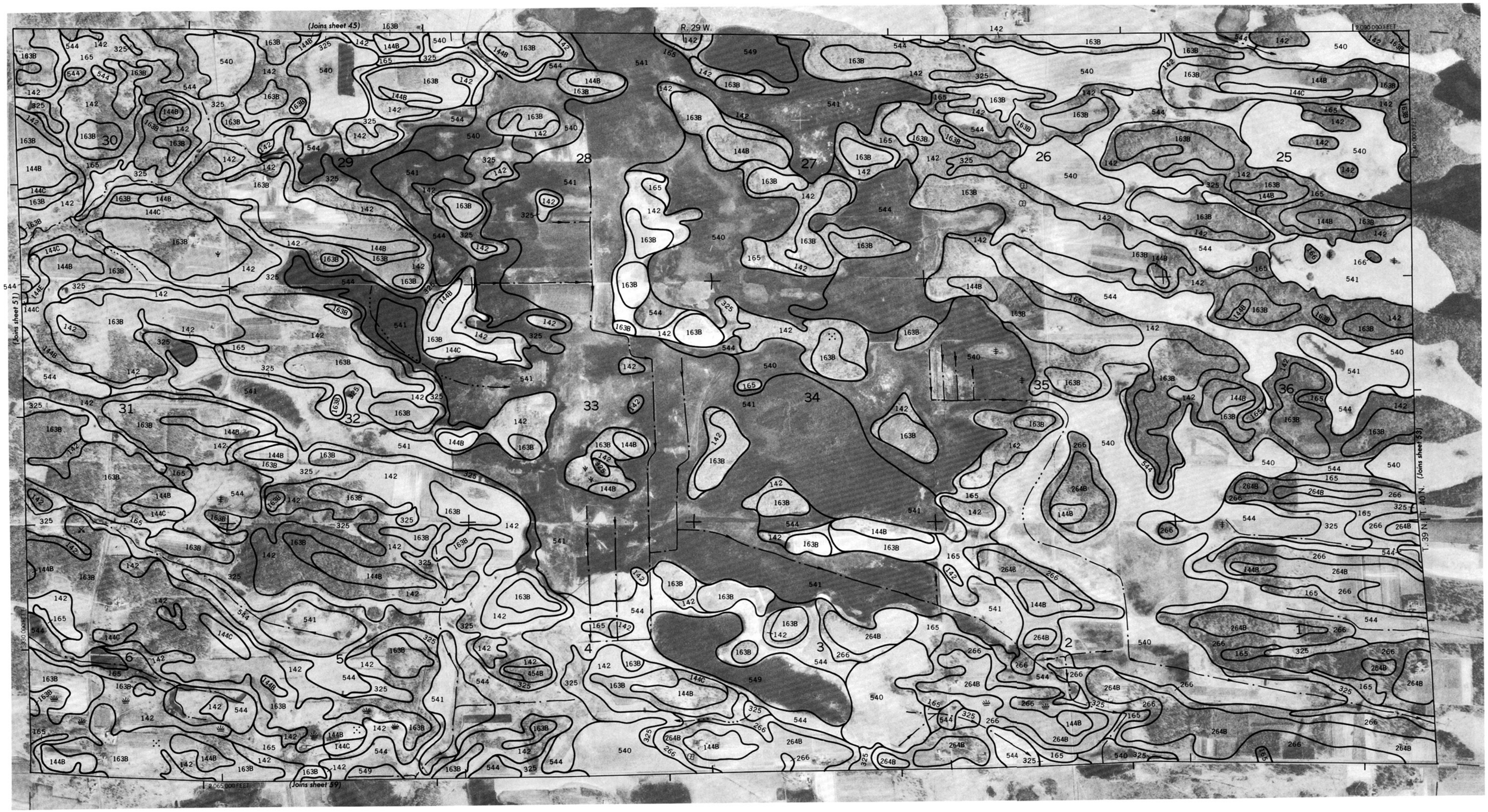

48
N
(Joins sheet 40)
R. 30 W.
1 960 000 FEET
Shays Island
(Joins sheet 42)
(Joins sheet 49)
T. 128 N.
T. 129 N.
MISSISSIPPI RIVER
Mud Lake
Swan River
Sobieski
(Joins sheet 47)
(Joins sheet 55)
1 920 000 FEET
31
32
33
34
35
36
6
5
4
3
2
1
7
8
9
10
11
12

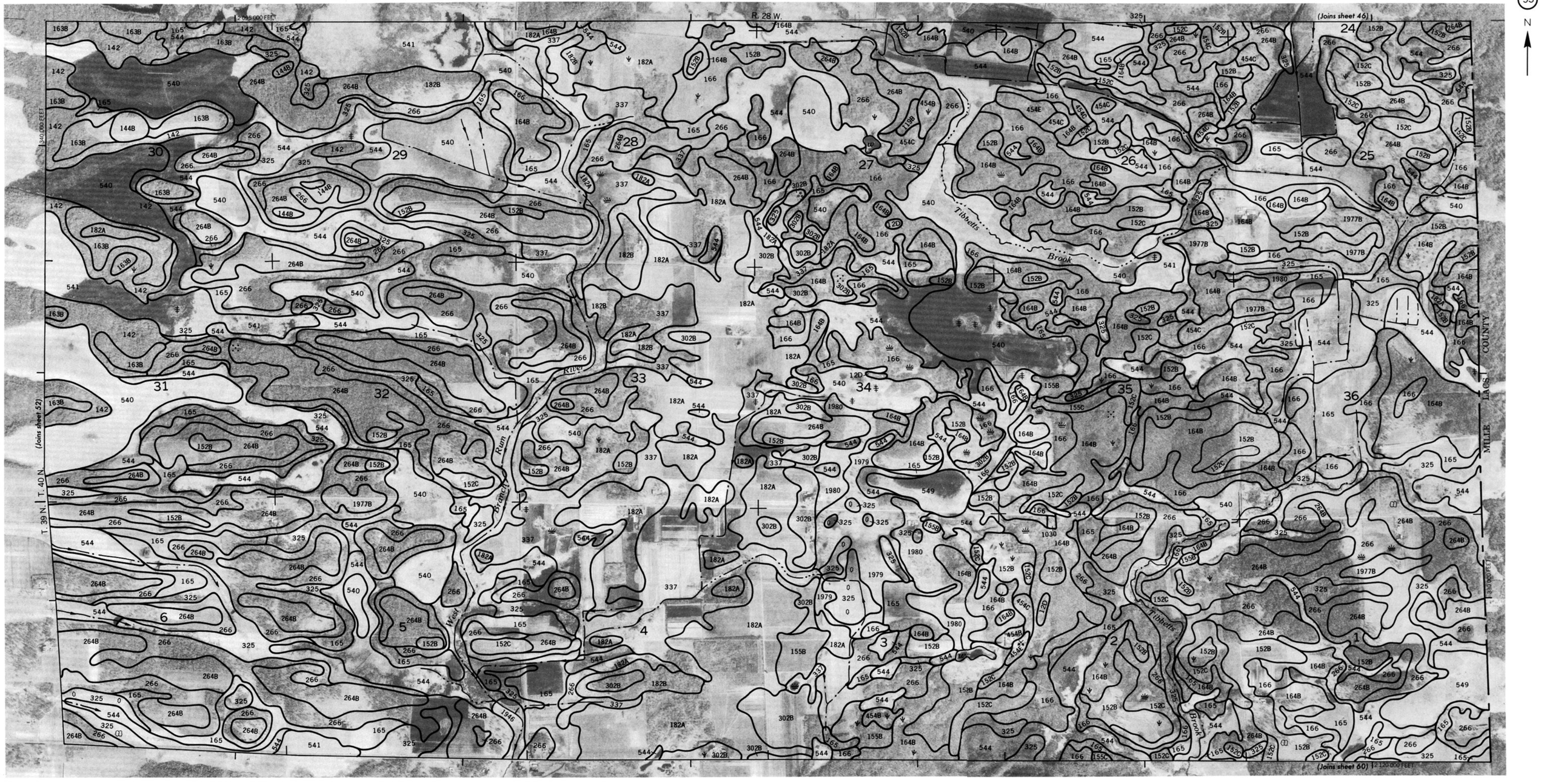
N

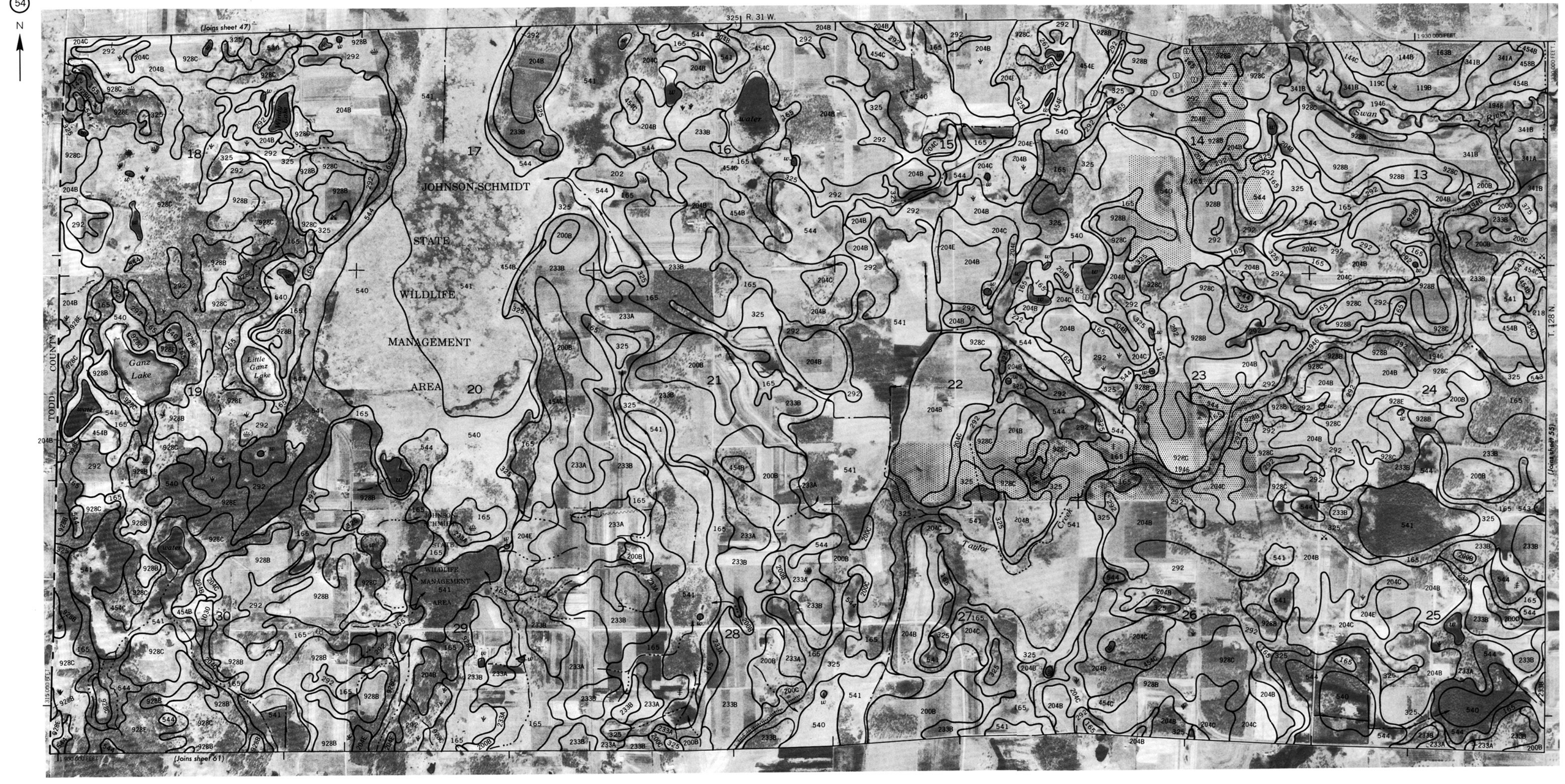

965 000 FEET
R. 32 W.
(Joins sheet 42)
MISSISSIPPI
RIVER
Zebulon
Pike
Lake
BURLINGTON
NORTHERN
PLATTE
RIVER
T. 128 N.
(Joins sheet 48)
T. 40 N.
(Joins sheet 50)
(Joins sheet 56)
R. 29 W.
30
29
28
27
26
25
31
32
33
34
35
36
6
7


50
N
R. 31 W.
2 025 000 FEET
340 000 FEET
330 000 FEET
2 000 000 FEET
T. 39 N.
T. 40 N.
(Joins sheet 43)
(Joins sheet 44)
(Joins sheet 56)
(Joins sheet 57)
(Joins sheet 51)
RICE LAKE
SKUNK LAKE
PLATTE RIVER
Skunk River
Mud Lake
water
Buckman Creek
Hillman Creek
RICE-SKUNK LINE
STATE WILDLIFE MANAGEMENT AREA
RICE-SKUNK STATE WILDLIFE MANAGEMENT AREA
Hillman
30
29
28
27
26
25
31
32
33
34
35
36
6
5
4
3
2
1

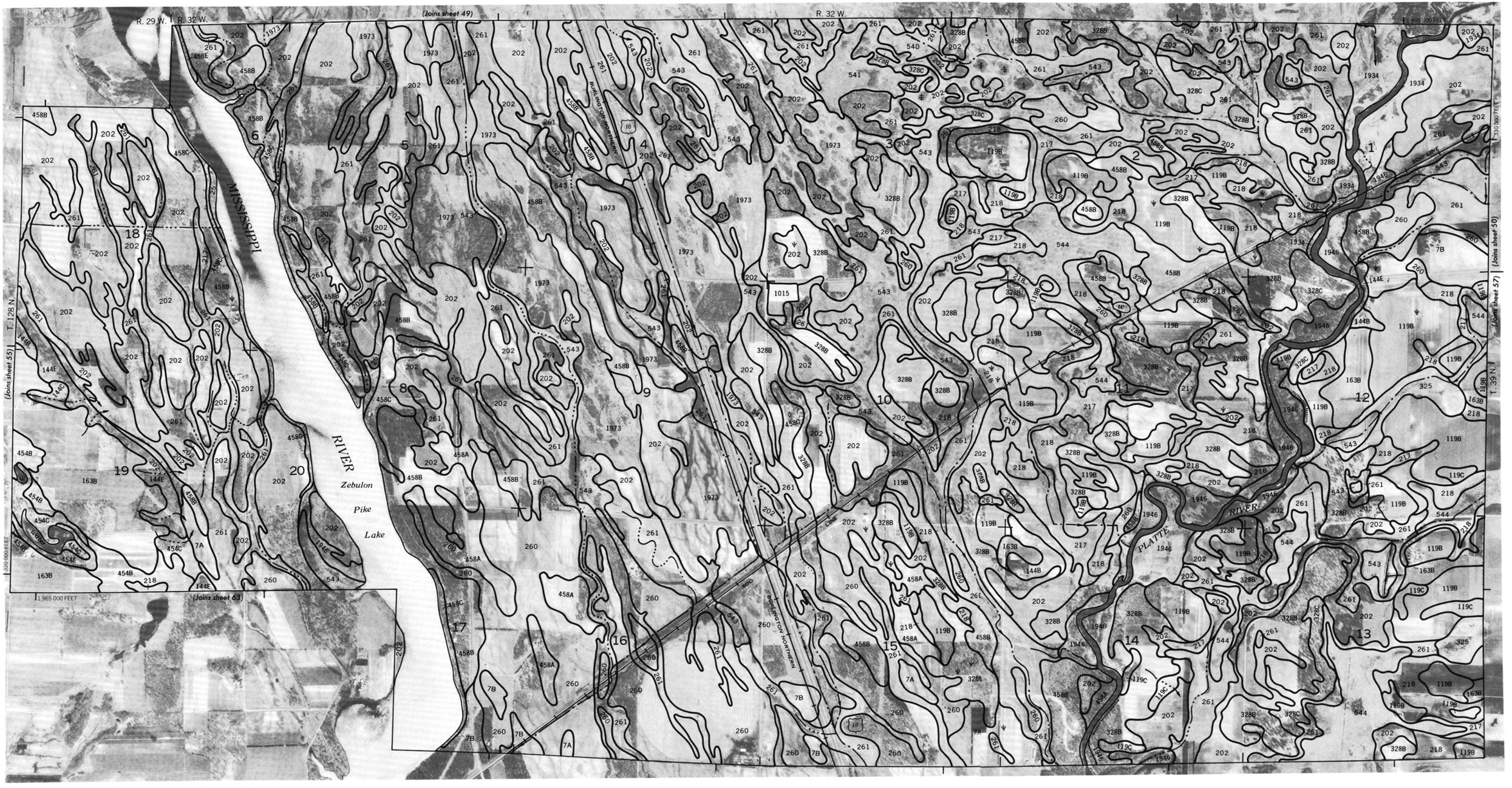

2 030 000 FEET
R. 30 W.
(Joins sheet 44)
340 000 FEET
T. 39 N.
T. 38 N.
(Joins sheet 50)
(Joins sheet 52)
330 000 FEET
(Joins sheet 58)
2 060 000 FEET
N
Skunk River
Skunk
water
Creek
Arramba Creek
Buckman Creek
Buckman
30
29
28
27
26
25
31
32
33
34
35
36
6
5
4
3
2
1

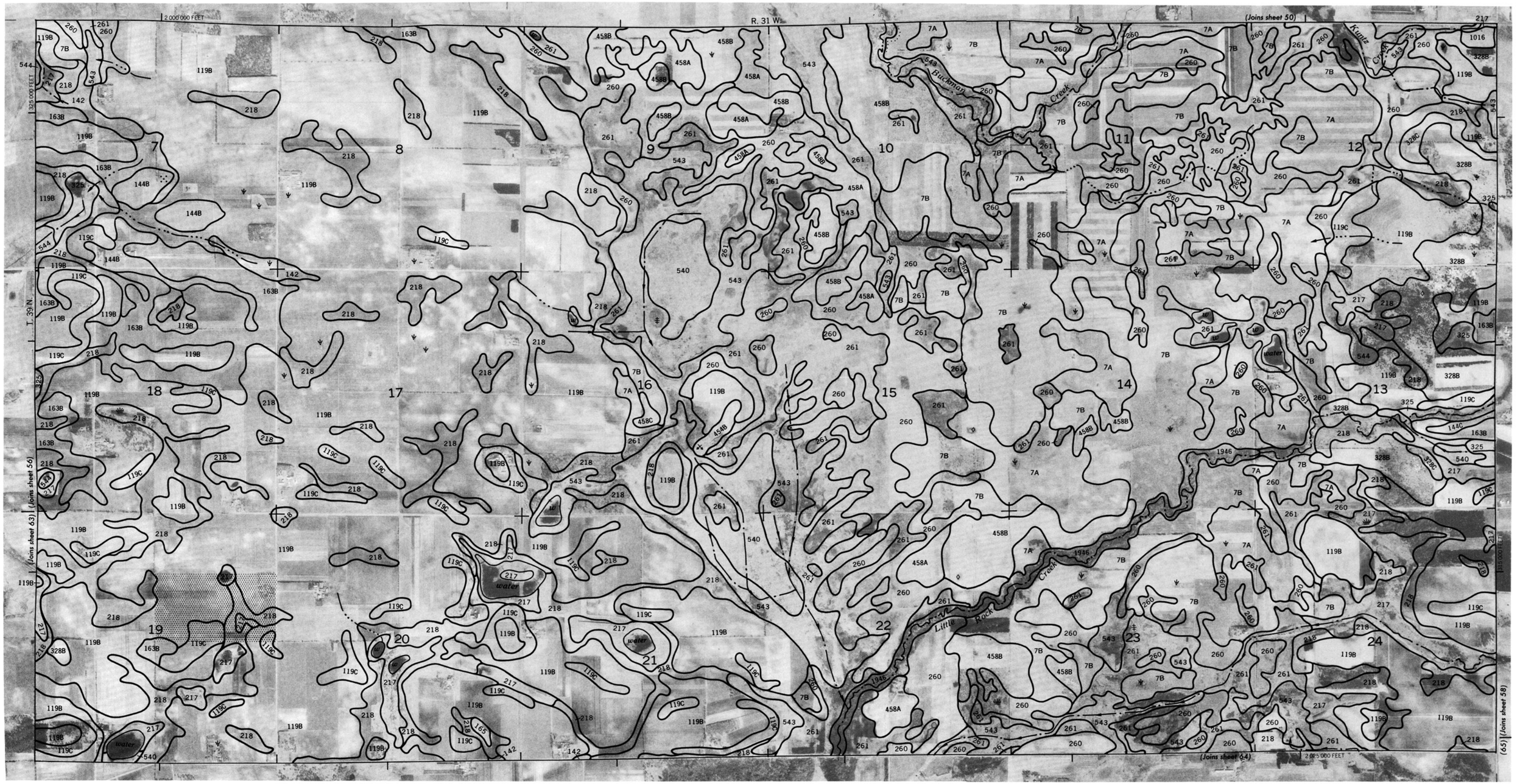

52
N
(Joins sheet 45)
R. 29 W.
2 080 000 FEET
2 070 000 FEET
2 060 000 FEET
(Joins sheet 51)
(Joins sheet 53)
(Joins sheet 59)
T. 39 N.
T. 40 N.
30
29
28
27
26
25
31
32
33
34
35
36
6
5
4
3
2
1


N
R. 28 W.
2 093 000 FEET
340 000 FEET
(Joins sheet 46)
(Joins sheet 52)
T. 40 N.
T. 39 N.
(Joins sheet 60)
2 120 000 FEET
830 000 FEET
MILLE LACS COUNTY
Rum River
West Branch
Tibbetts Brook
Tibbetts Brook
1 2 3 4 5 6
7 8 9 10 11 12
13 14 15 16 17 18
19 20 21 22 23 24
25 26 27 28 29 30
31 32 33 34 35 36


54
N
(Joins sheet 47)
325
R. 31 W.
1 930 000 FEET
JOHNSON-SCHMIDT
STATE
WILDLIFE
MANAGEMENT
AREA
Ganz Lake
Little Ganz Lake
water
Swan River
Tadfor Creek
T. 128 N.
TODD COUNTY
315 000 FEET
(Joins sheet 61)
(Joins sheet 55)


N
R. 30 W.
T. 128 N.
(Joins sheet 48)
(Joins sheet 54)
(Joins sheet 62)
(Joins sheet 63)
(Joins sheet 55)
1 960 000 FEET
330 000 FEET
315 000 FEET
Swan River
Star Lake
O'Donald Lake
Meadow Creek
Hay Creek
17
18
16
15
14
13
19
20
21
22
23
24
30
29
28
27
26
25


56
N
R. 29 W.
R. 32 W.
(Joins sheet 49)
(Joins sheet 55)
(Joins sheet 63)
(Joins sheet 57)
(Joins sheet 50)
T. 128 N.
T. 39 N.
1 965 000 FEET
320 000 FEET
330 000 FEET
MISSISSIPPI
RIVER
Zebulon
Pike
Lake
PLATTE
RIVER
BURLINGTON NORTHERN
BURLINGTON NORTHERN
1015

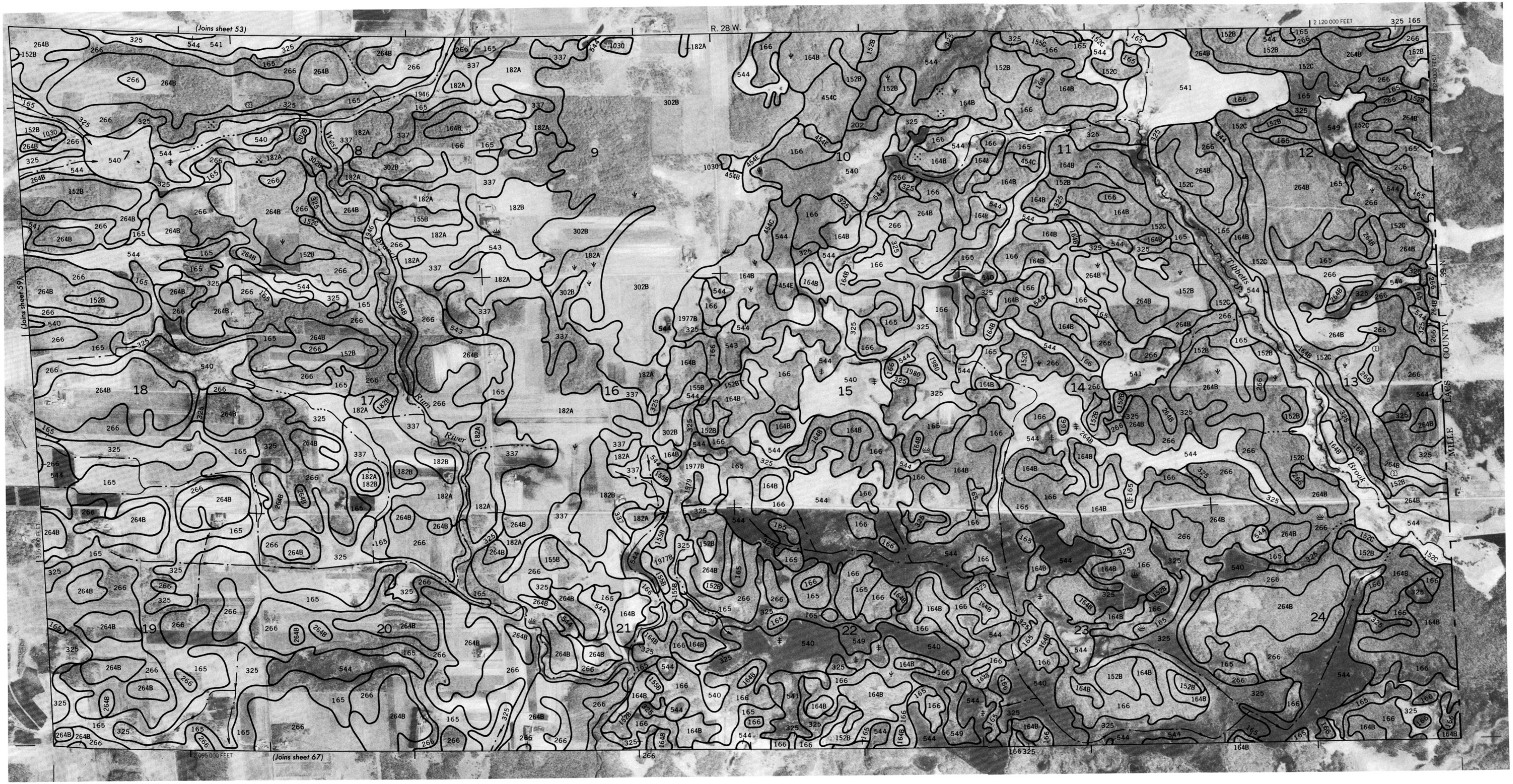

2 000 000 FEET
R. 31 W.
(Joins sheet 50)
325 000 FEET
T. 39 N.
(Joins sheet 56)
(Joins sheet 63)
Buckman Creek
Kuntz Creek
Little Rock Creek
water
(Joins sheet 64)
2 025 000 FEET
(65) (Joins sheet 58)
N

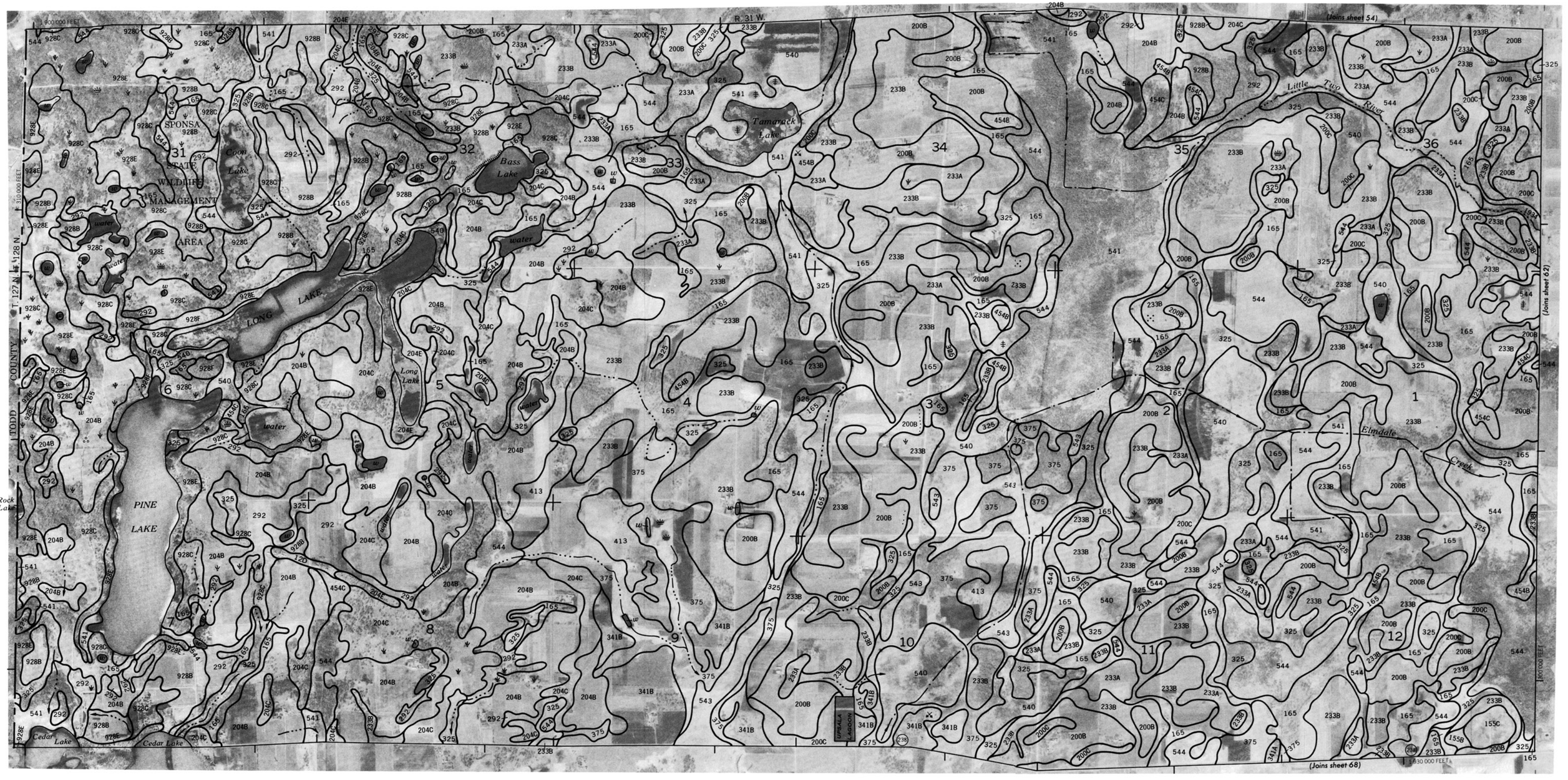

58
N
(Joins sheet 51)
R. 30 W.
Buckman
Coon
Lake State
Kuntz
Coon
Lake
Wild
Life
Management
Area
Creek
Little
Rock
Creek
Mississippi
Creek
water
T. 39 N.
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 65)
2 060 000 FEET
2 030 000 FEET
325 000 FEET
1 995 000 FEET
1 965 000 FEET
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

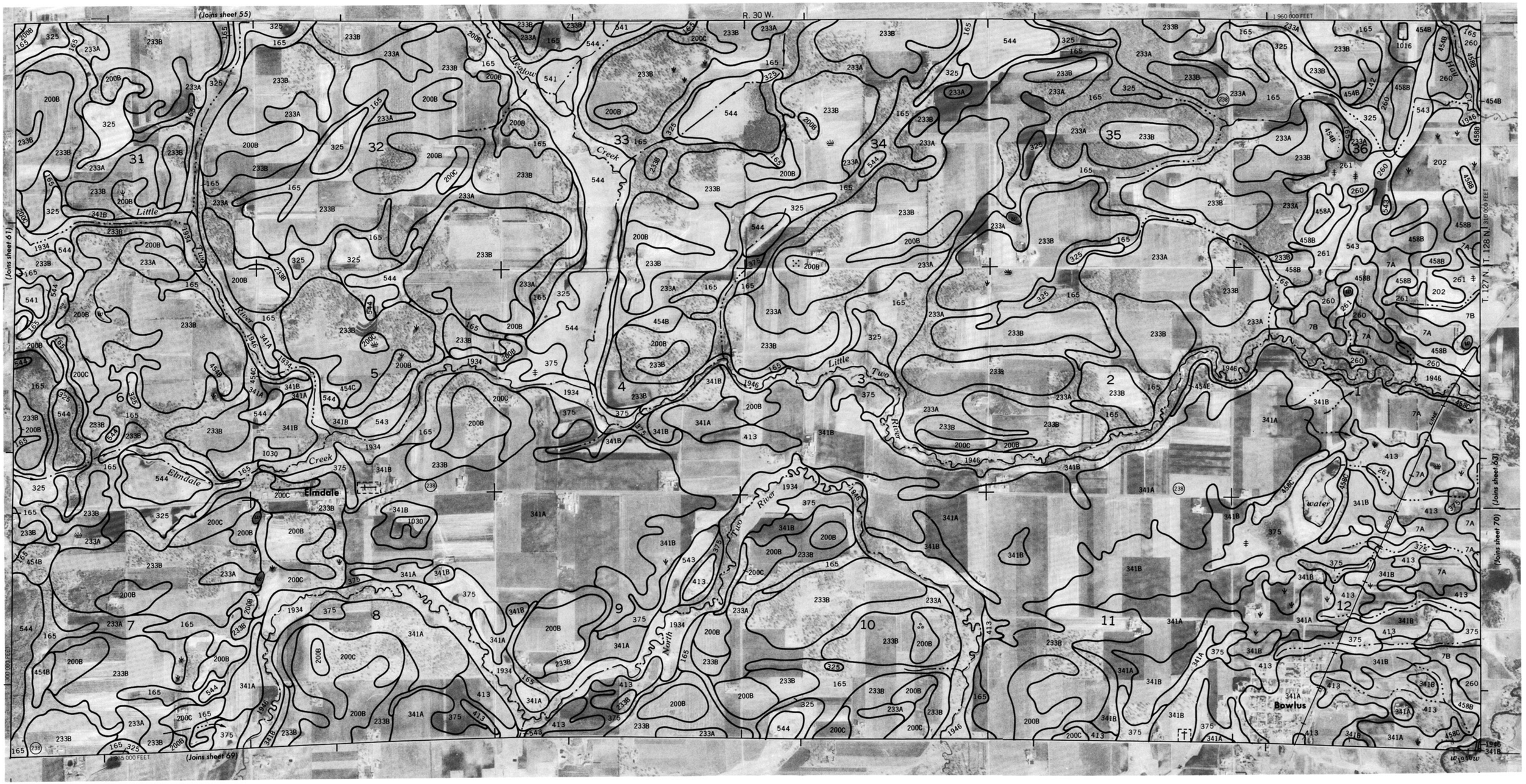

N
2 065 000 FEET
R. 29 W.
(Joins sheet 52)
325 000 FEET
T. 39 N.
(Joins sheet 58)
(Joins sheet 60)
315 000 FEET
(Joins sheet 66)
2 090 000 FEET
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

60

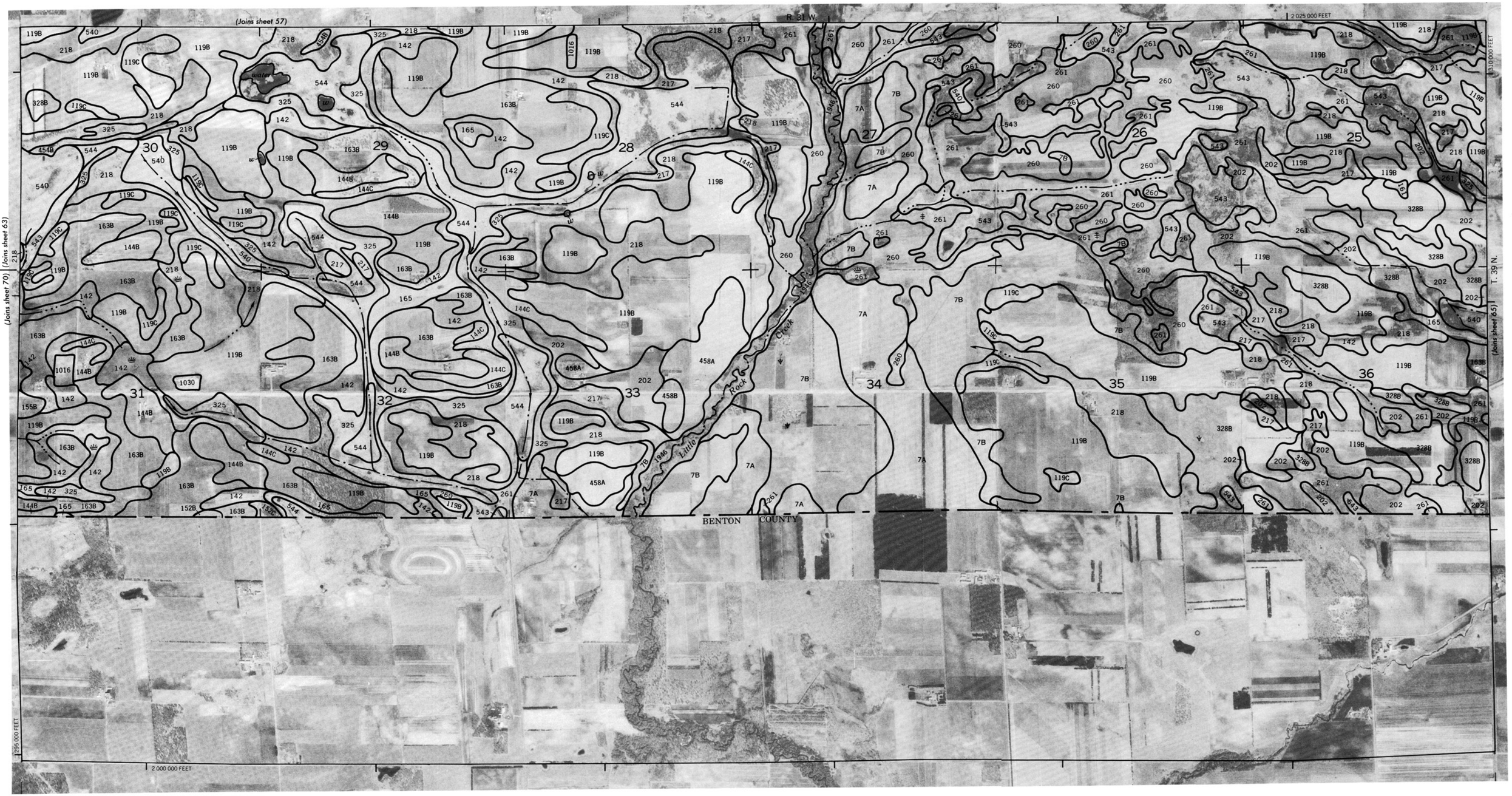
N

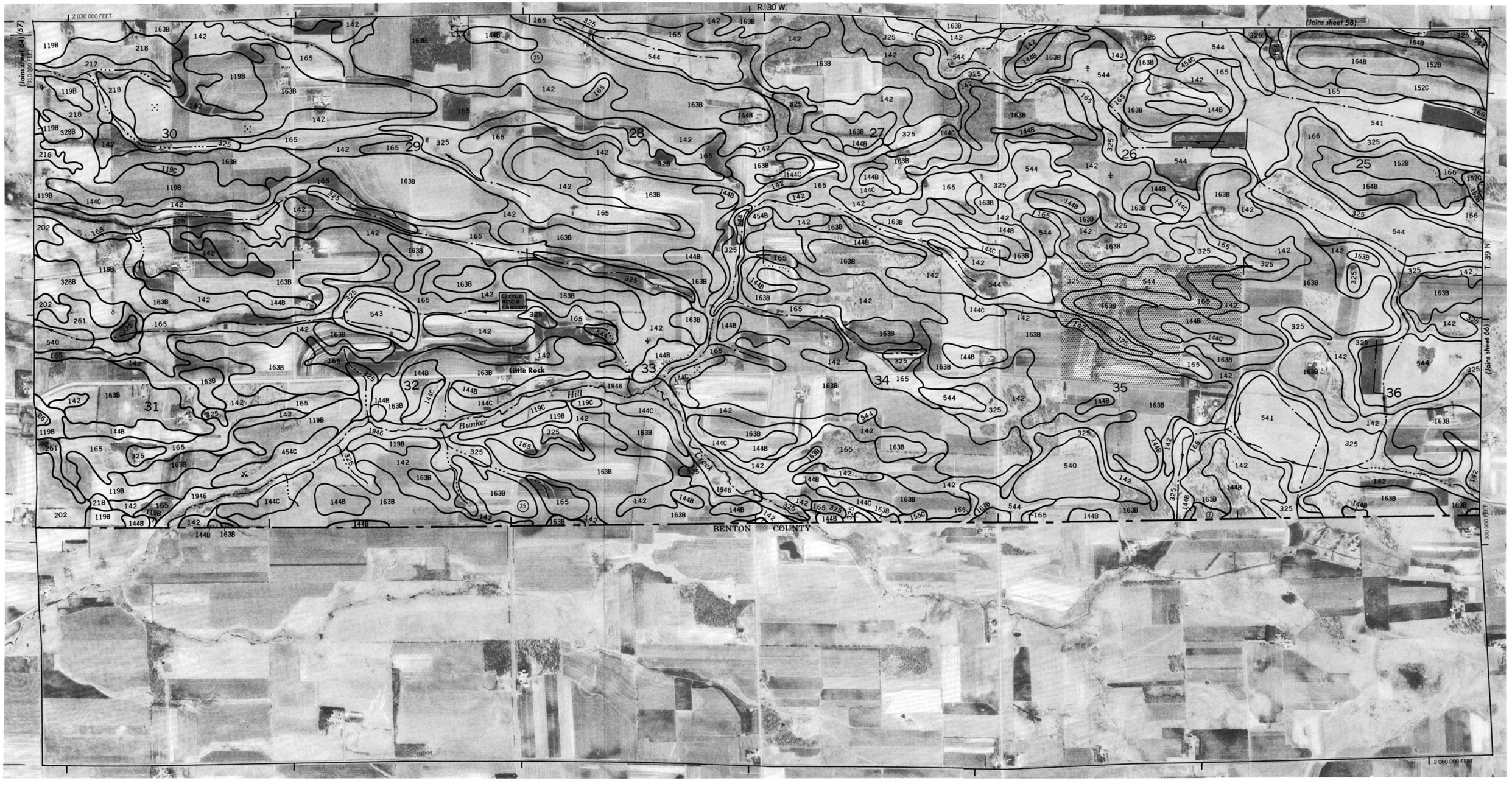

(Joins sheet 53)
R. 28 W.
2 120 000 FEET
(Joins sheet 59)
(Joins sheet 67)
2 095 000 FEET
315 000 FEET
T. 39 N.
MILLE LACS COUNTY
West Branch Rum River
Tibbetts Brook


N
R. 31 W.
T. 127 N.
T. 128 N.
TODD COUNTY
1 900 000 FEET
310 000 FEET
1 930 000 FEET
(Joins sheet 54)
(Joins sheet 62)
(Joins sheet 68)
SPONSA
STATE WILDLIFE MANAGEMENT AREA
Coon Lake
Bass Lake
Tamarack Lake
LONG LAKE
Long Lake
PINE LAKE
Rock Lake
Cedar Lake
Cedar Lake
Little Twp River
Elmdale Creek
water
31
32
33
34
35
36
6
5
4
3
2
1
7
8
9
10
11
12


62
N
(Joins sheet 55)
R. 30 W.
1 960 000 FEET
(Joins sheet 61)
T. 128 N.
T. 127 N.
310 000 FEET
(Joins sheet 63)
(Joins sheet 70)
(Joins sheet 69)
1 925 000 FEET
Little
Elmdale
Creek
River
Two
North
Meadow
Creek
Little
Two
River
Elmdale
Creek
River
water
Bowlus
31
32
33
34
35
36
5
4
3
2
1
6
7
8
9
10
11
12


R. 29 W.
R. 32 W.
MISSISSIPPI RIVER
Zebulon Pike Lake
BLANCHARD DAM
MISSISSIPPI RIVER
McDougall Island
PLATTE RIVER
Royalton
BURLINGTON NORTHERN
T. 127 N.
T. 128 N.
T. 39 N.
(Joins sheet 55)
(Joins sheet 56)
(Joins sheet 57)
(Joins sheet 62)
(Joins sheet 64)
(Joins sheet 70)
1 965 000 FEET
1 995 000 FEET
N


64
N
(Joins sheet 57)
R. 31 W.
2 025 000 FEET
310 000 FEET
T. 39 N.
(Joins sheet 63)
(Joins sheet 70)
(Joins sheet 65)
295 000 FEET
2 000 000 FEET
BENTON COUNTY
Rock Creek
Little
water
30
29
28
27
26
25
31
32
33
34
35
36


R.30 W.
2 030 000 FEET
(Joins sheet 57)
(Joins sheet 58)
(Joins sheet 64)
(Joins sheet 66)
T. 39 N.
300 000 FEET
2 060 000 FEET
N
65
30
29
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25
31
32
33
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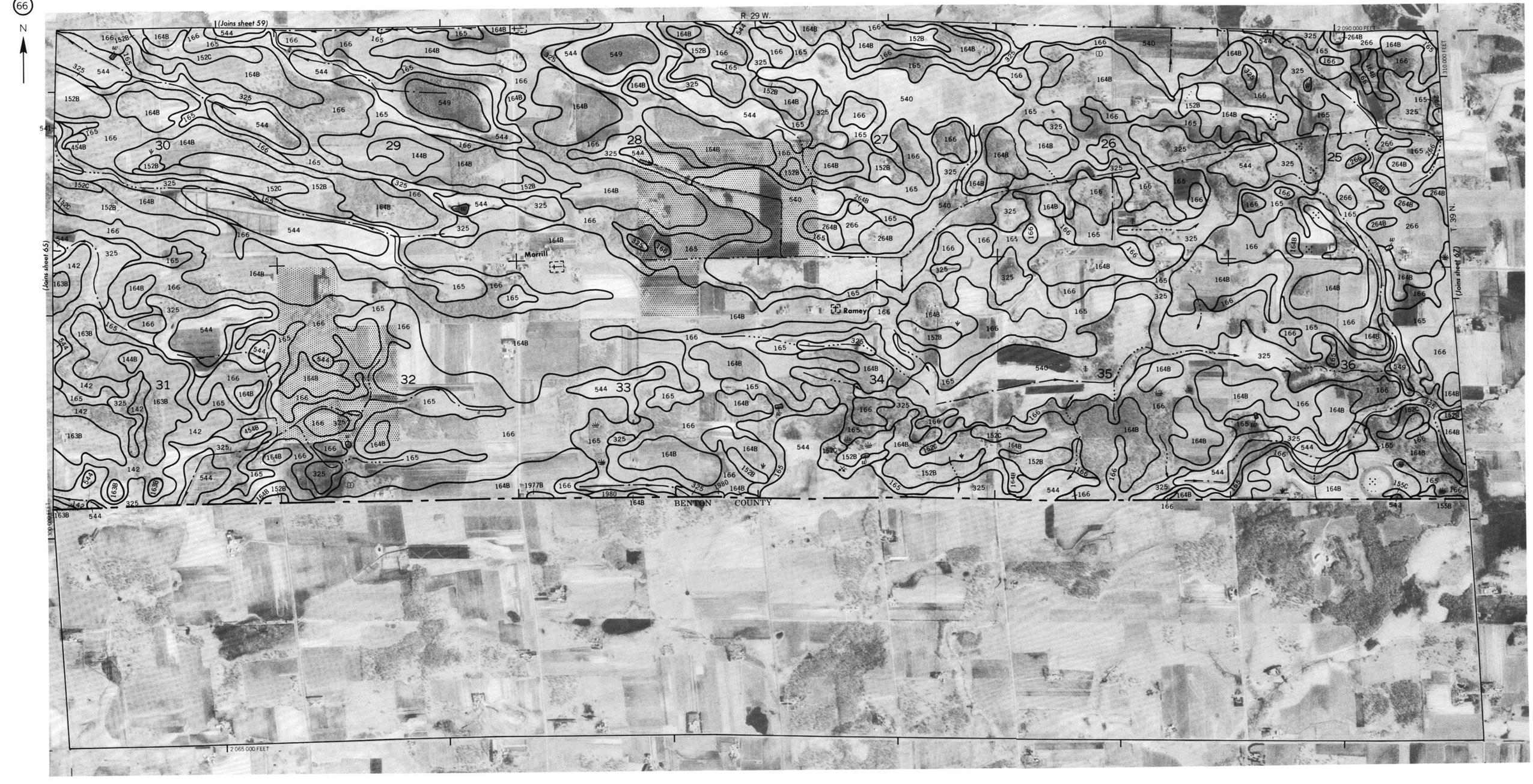
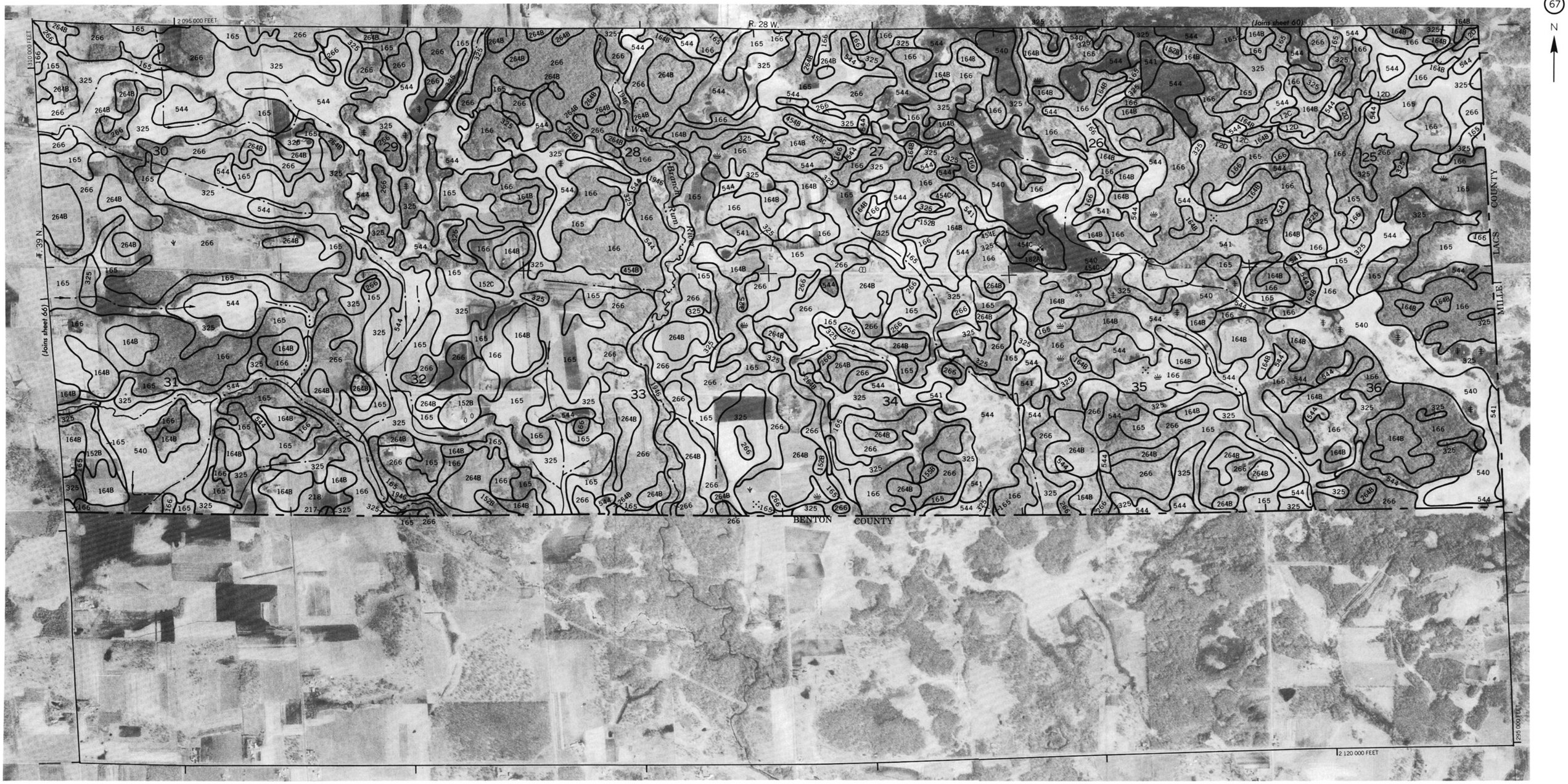
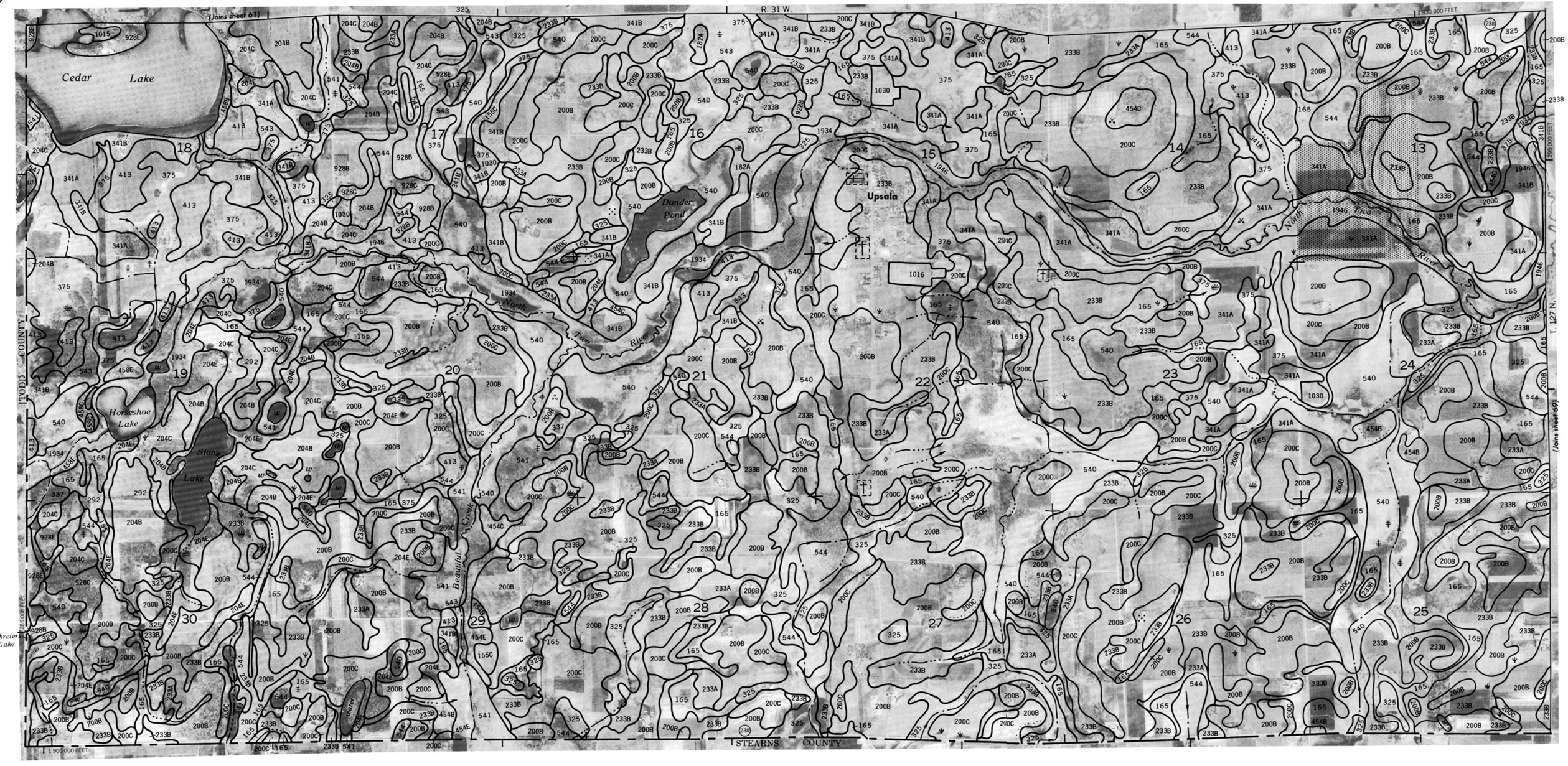
35
36
LITTLE ROCK LAGOON
Little Rock
Hill
Bunker
Creek
BENTON COUNTY


66
N
(Joins sheet 59)
R. 29 W.
2 090 000 FEET
310 000 FEET
T. 39 N.
(Joins sheet 65)
(Joins sheet 67)
Morrill
Ramey
BENTON COUNTY
2 065 000 FEET
30 000 FEET


N
2 095 000 FEET
R. 28 W.
(Joins sheet 60)
T. 39 N.
(Joins sheet 66)
1 310 000 FEET
30
29
28
27
26
25
31
32
33
34
35
36
Bergen Run
Rice
BENTON COUNTY
MILLE LACS COUNTY
2 120 000 FEET
295 000 FEET


68
N
(Joins sheet 61)
R. 31 W.
1 930 000 FEET
Cedar Lake
Dunder Pond
Upsala
North Two River
Horseshoe Lake
Stony Lake
Beautiful Creek
Schreier Lake
1 925 000 FEET
1 900 000 FEET
COUNTY
STEARNS COUNTY
T. 127 N.
(Joins sheet 69)
18
17
16
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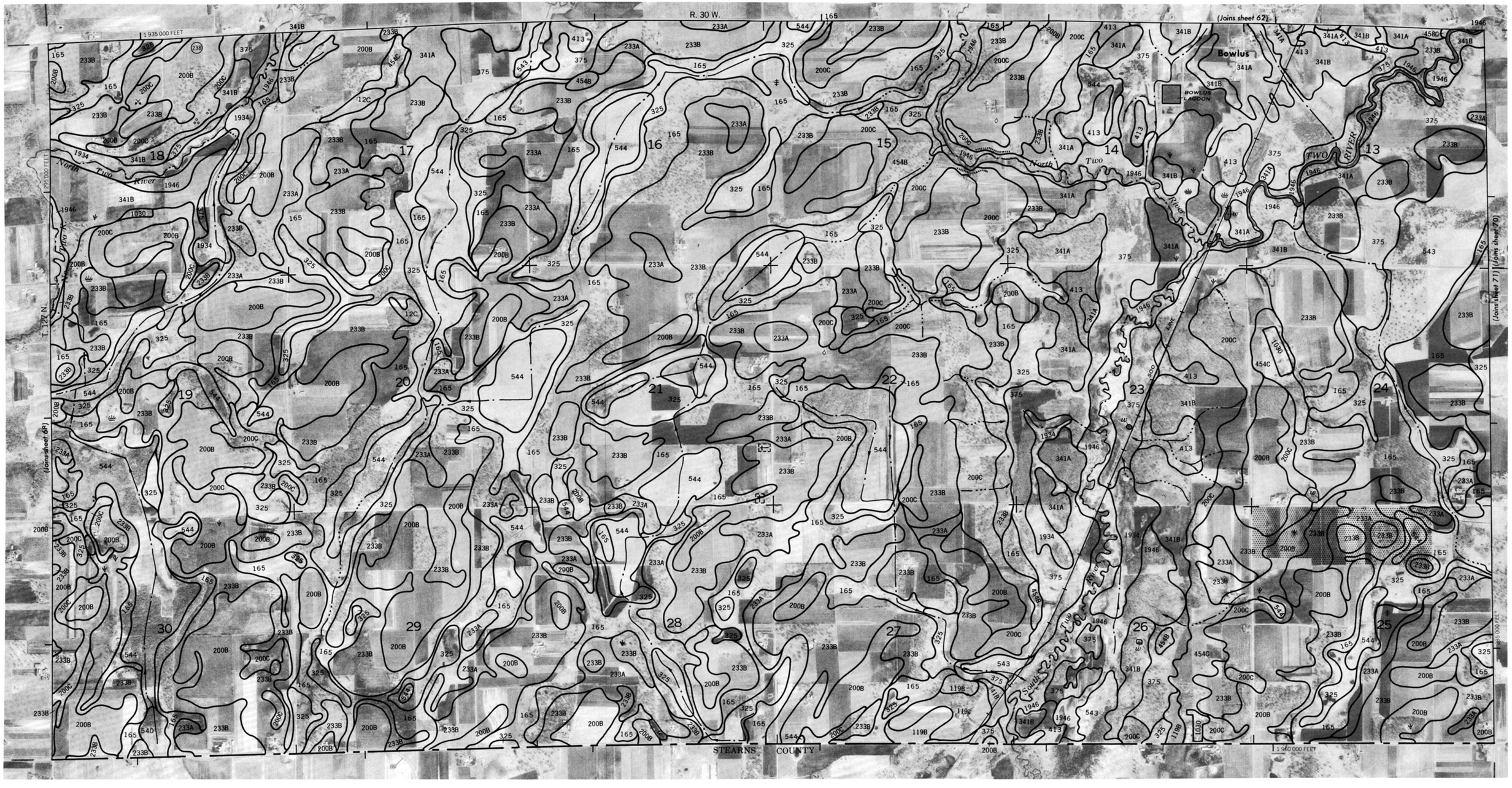
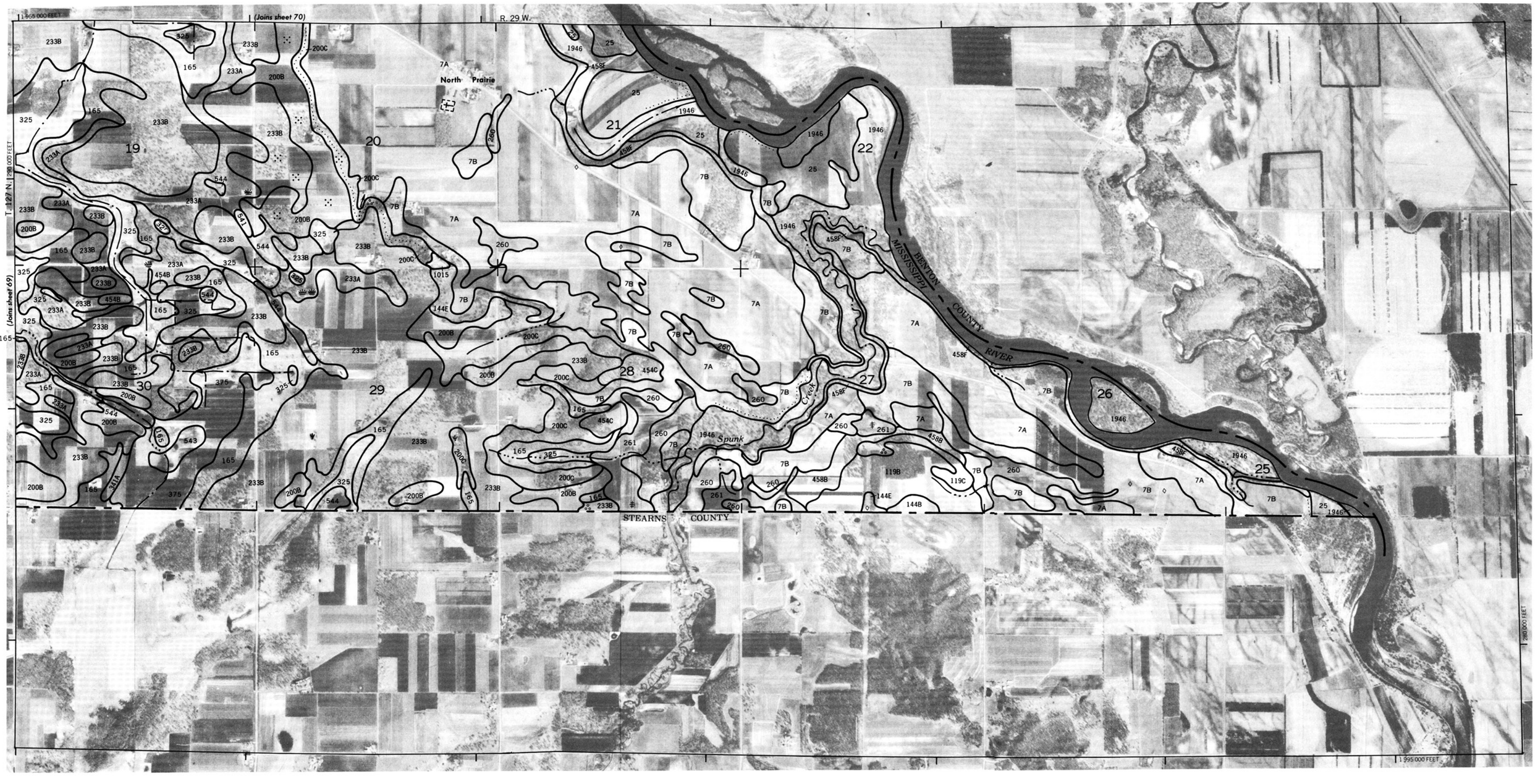

R. 30 W.
(Joins sheet 62)
1 935 000 FEET
1 960 000 FEET
T. 129 N.
(Joins sheet 69)
(Joins sheet 70)
(Joins sheet 71)
Bowlus
BOWLUS LAGOON
North Two River
TWO RIVER
South Two River
STEARNS COUNTY
N


70
N
R. 29 W.
R. 32 W.
T. 127 N.
T. 39 N.
(Joins sheet 63)
(Joins sheet 62)
(Joins sheet 69)
(Joins sheet 71)
(Joins sheet 64)
MISSISSIPPI RIVER
Little Two River
Two River
Hazel Creek
PLATTE RIVER
BENTON COUNTY
BENTON COUNTY
Royalton
BURLINGTON
NORTHERN
1 995 000 FEET
1 965 000 FEET
295 000 FEET
32
33
34
35
36
7
8
17
18
16


1 965 000 FEET
(Joins sheet 70)
R. 29 W.
North Prairie
MISSISSIPPI RIVER
BENTON COUNTY
Spunk Creek
STEARNS COUNTY
(Joins sheet 69)
T. 127 N.
280 000 FEET
1 995 000 FEET
N